25 KG INGOT HEIGHT CONTROL SYSTEM

BY

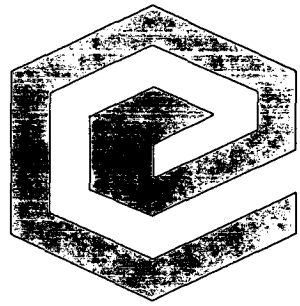
PAUL A. ELLIOTT

A report submitted in fulfilment of the
requirements for the
Degree of Master of Technology
(Power Engineering & Process Control)

Department of Electrical & Electronic Engineering
University of Tasmania
Australia

Supervisor	Supervisor
Mr. C. Wood	Mr. J. Arneaud
Comalco Aluminium Ltd	University of Tasmania

NOVEMBER 1993



COMALCO

COMALCO ALUMINIUM (BELL BAY) LIMITED

METAL PRODUCTS

25 Kg Ingot Height Control System

ACKNOWLEDGMENTS

I would like to thank Comalco Aluminium (Bell Bay) Ltd. for the opportunity and support given during my Master of Technology Degree Course at the University of Tasmania (Hobart). I would also like to thank my supervisors Colin Wood (Comalco) and John Arneaud (University) for the interest shown in this project.

ABSTRACT

This thesis represents an industrial project to control the size of 25kg aluminium ingot as it is being cast, on the No.1 ingot machine in the Metal Products MRU, Comalco Aluminium Bell Bay. The project consisted of the proposal, design, install and commission of an Ingot Height Control System. The result of the project is a system which has reduced physical scrap (in terms of bundle weight) by 1450 tonnes year to date (y.t.d.).

TABLE OF CONTENTS

cont...

Table of Contents cont.

cont...

Table of Contents cont.

LIST OF FIGURES

APPENDICES

cont...

Table of Contents cont.

1. INTRODUCTION

1.1 Ingot Casting Facilities

Molten aluminium is supplied from Potrooms and stored prior to casting in holding furnaces. Two furnaces are available, an electric furnace No.6 and an oil fired furnace No.7 for the No.1 ingot machine facility. The No.6 Tilting Furnace has a capacity of 40 tonnes of molten aluminium, and the No.7 fixed furnace has a capacity of 15 tonnes. The metal is maintained at temperature between 700 and 750°C.

The No.6 tilting furnace mechanism consists of two hydraulic lifting rams attached to the furnace, and lift the furnace about two pivot points adjacent to where the aluminium is discharged. As the furnace is lifted the aluminium is discharged to the feed launders for the casting machine.

1.2 Details of Ingots To be Cast

The ingot casting machine comprises of a continuous loop of 92 cast iron moulds (ingot size nominal 22.7 kg's) mounted on twin strands of conveyor chain driven by a variable speed electric motor, the speed of which is adjusted to provide control over the filling of the moulds at the initial start of the cast and the cast rate. Mould filling is automatically controlled during the cast by the ingot height control system. The casting machine is fed from a 40 tonne capacity tilting furnace, or a 15 tonne fixed furnace, via a rotary distribution tundish geared to the casting machine drive. The metal temperature when it enters the mould is typically around 720°C. Typical cast rates are in the order of 9-11 tonnes/hour (the cast rate being limited by the length of the casting machine).

The ingots are then cooled by passing over water sprays. The ingot moulds are pivoted along their leading edge such that as the moulds pass their points of balance when moving around the conveyor head sprockets, they flop downwards and strike two solid fixed anvils which provide the necessary ejection blow and propel the ingot downwards onto a curved plate and delivered (ingot skin temperature of up to 550°C) onto another cooling conveyor. The ingots are cooled further by water sprays above the cooling conveyor. The ingots exit the cooling conveyor at around 60°C. Ingots are then aligned in preparation for stacking on an automated stacking system. The stacking system comprises of two Staubli electric robots, which stack the ingots in predetermined bundle sizes and configurations.

Mean Actual Ingot Dimensions

Overall length	828 mm
Overall width	210 mm
Overall height	80 mm
Average mass	22.7 kg

2.0 DISCUSSION

This project is as a result of poor metal flow control from No. 6 and No.7 furnaces to the No. 1 ingot casting machine in Metal Products. The requirement is to control the furnaces from their full to empty state with absolute minimum ingot size variation.

There was no launder level control systems on any of the furnaces in Metal Products at Bell Bay to assist the operator in maintaining constant metal flow. With such primitive tilt control, and no level control, reliable consistency could not be expected from the operator, as each has different heuristics.

Previously metal flow control was based on an operator assessment of the molten metal height in the moulds, the furnace then tilted up or down to achieve the desired mould metal level. This form of control was very operator dependent and compounded in difficulty by a fluctuation in mould levels in the casting belt.

The previous tilt control consisted of a proportional flow control valve adjusted by the operator by means of a potentiometer, to raise the furnace according to the metal flow. The problem with this method was the metal flow from the furnace varies as the furnace is raised necessitating constant adjustment by the operator.

There was a tendency for the metal flow to reduce during a cast which would require a corresponding reduction in belt speed. This is not desirable as it reduces the capacity of the casting machine.

The result of the above deficiencies, required constant operator adjustment of the proportional control or basic tilt on/off control to achieve the desired

metal flow. Either method cannot maintain the level variations at the accuracy required. The level variations were of the order of 3-7 mm at best. To that end it was proposed to automate the metal flow process by means of launder level and ingot height control.

3.0 OBJECTIVES

The objective of the project was to accurately and consistently control the quantity of aluminium supplied to each mould during the ingot casting process, from the No.6 tilting furnace and the No.7 fixed furnace to No. 1 ingot casting machine, see Fig.1.

The project consisted of three stages,

3.1 Stage 1

The aim was to control the No.6 furnace tilt from the full to empty state with the absolute minimum launder level variation for the entire cast, in order to achieve a consistent flow rate, see Fig.2.

3.2 Stage 2

The aim was to utilise an ingot height measurement system to automate the actuation of the weir based on feedback of the ingot height, and to gain an understanding of the process, see Fig.3.

3.3 Stage 3

The aim was to control the No.7 furnace tap hole plug assembly automatically from the full to empty state with the absolute minimum launder level variation for the entire cast, in order to achieve a consistent flow rate, see Fig.2.

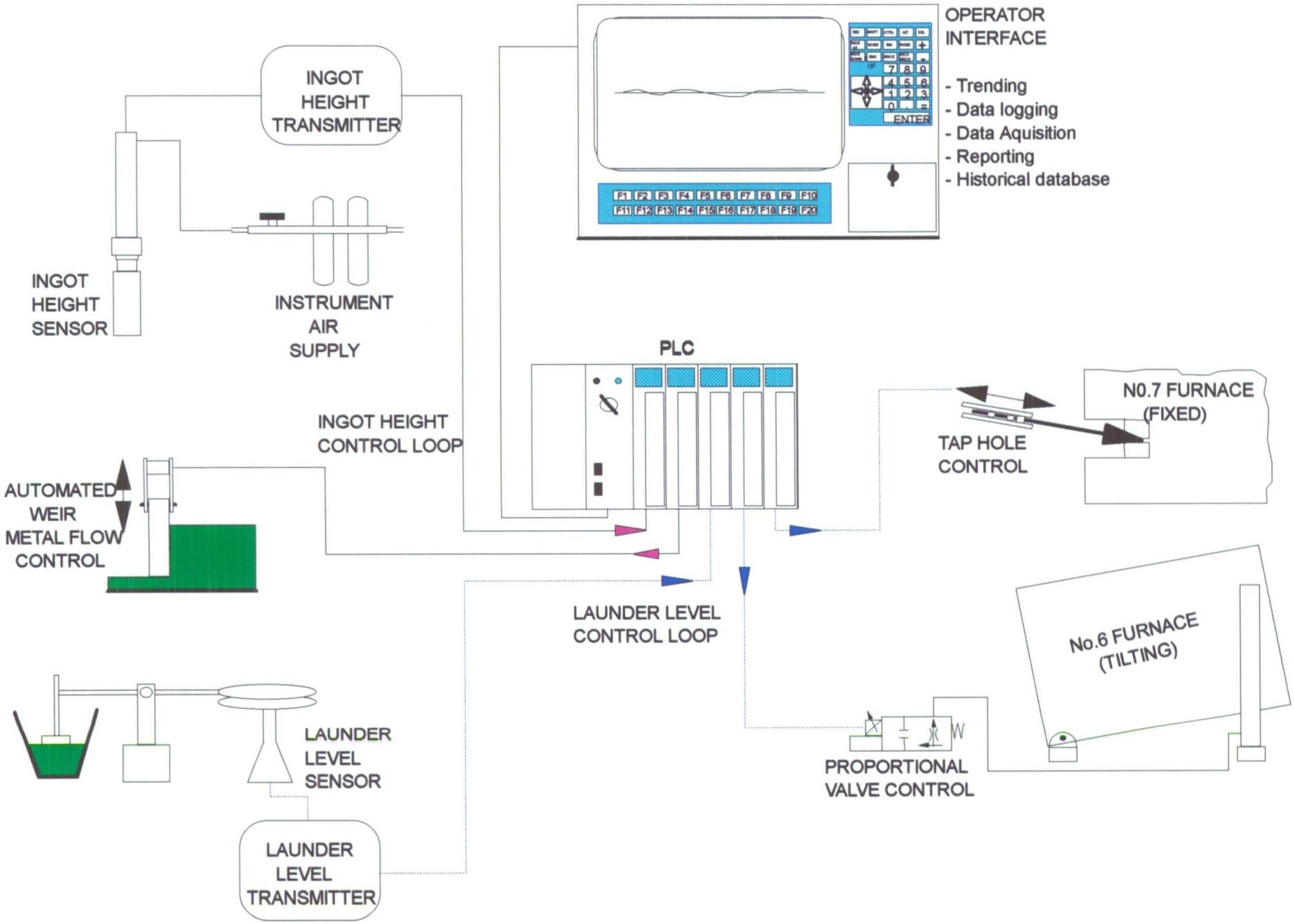


Figure 1 No.1 INGOT MACHINE METAL FLOW CONTROL

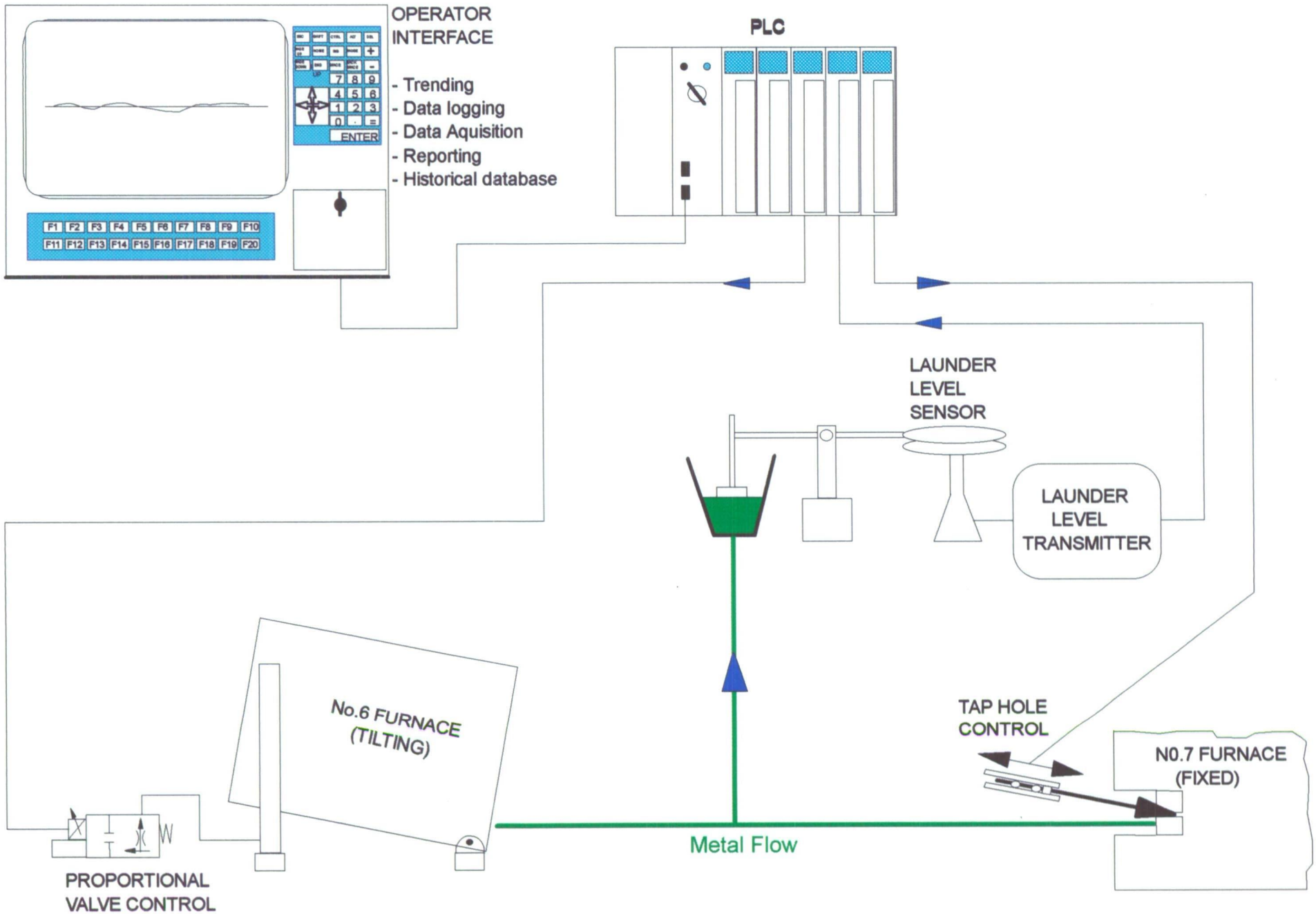


Figure 2 LAUNDER LEVEL CONTROL LOOP

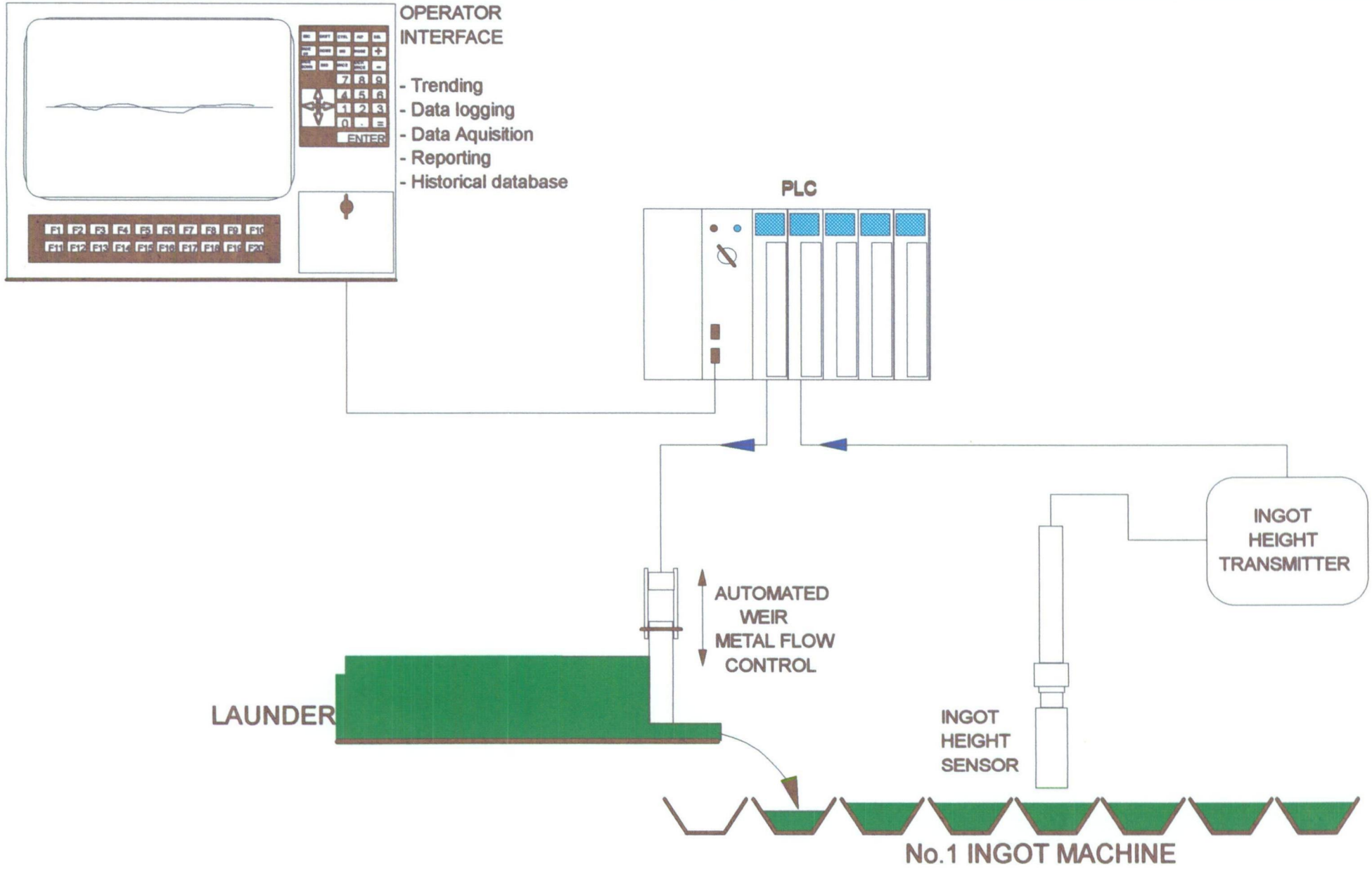


Figure 3 INGOT HEIGHT CONTROL LOOP

4.0 BENEFITS

The benefits of the control system are as follows :

4.1 Financial

Prior to installation of the ingot height control system, 10% of 22-kg ingot produced was out of specification (London Metal Exchange, LME) physically.

With 53 597 tonnes of 22-kg ingot production planned for 1992-93 this equates to 5360 tonnes of metal which can not be offered on the LME.

The out of specification ingot produced year to date (y.t.d.) is 0.49% out of the No.6 Furnace and 1.7% out of the No.7 Furnace. Resulting in a payback period of less than 6 months.

4.2 Safety (Launder Overflow Prevention)

Metal spill from the No.6 furnace or launder arrangement could be detrimental to 22-kg ingot production. Due to the close proximity of control panels (for furnace and ingot casting machine), it is necessary to ensure that metal spill from ingot production does not occur. With the launder monitoring system currently installed there has been no metal overflows from this facility.

The design, is such that if the launder level were to exceed a preset value the furnace tilt would be disabled and/or the furnace dropped back. There are two systems in place, the first is the analogue signal of the metal level, the second is a proximity switch. Either system is capable of disabling the furnace tilt, or lowering the furnace.

4.3 Future

With the function of real time displays (trending, histograms, etc.) and data capture a basic understanding of the process can now be attained, evaluated and a course of action taken to further improve the system.

The system, now that it has been developed and proven, is being utilised at other casting facilities within Metal Products.

Modifying the No.7 Tap hole so that the plug remains submerged would ensure that the freezing of the tap hole does not occur, ensuring a consistent and predictable flow of metal.

4.4 General

Now that a more consistent ingot is obtained, tolerances within the robot stacking system have been minimised to obtain tighter packed bundles. The benefit being, bundles when strapped remain tight when transported, thereby reducing the existing problems of loose strapping.

With metal flow control the cast rate is more steady, as flow fluctuations from the furnace have been minimised from the furnace full to empty state.

a) improve casting speed
b) improve (minimise) operator control
c) fewer reject ingots,
d) tighter packed bundles, that will maintain their stability throughout transportation,
e) safety (launder overflow prevention)
f) gain an understanding of the process

A short explanation of each benefit:

a) Improve casting speed

The options when the furnace was less than half full and the metal flow rate begins to reduce, was to slow the casting conveyor accordingly or increase operator control of the furnace tilt as the cast continues. The results being, a slower cast rate or more metal flow fluctuations and larger ingot variance.

With launder level control the cast speed can be maintained at a fixed rate with minimal flow fluctuations.

b) Improve (minimise) operator control

On completion of stage 1, the operator no longer controls the furnace tilt, and operation of the weir once set can be left alone. This results in a regulated flow of metal for the entire cast, leaving the only control required by the operator, is minimal belt speed variation.

On completion of stage 2 once the cast is underway, minimal operator control is required i.e. the system is a closed loop whereby the system will "tune" itself automatically to maintain a fixed ingot height.

c) Fewer reject ingots,

Bringing the system under control as mentioned above, improves the dimensional uniformity of each ingot.

d) Tighter packed bundles,

Once a more consistent ingot is obtained, tolerances within the robot stacking system are minimised to obtain a tighter packed bundle.

The result being, that bundles when strapped will remain tight when transported, thereby reducing the problems of loose strapping.

e) Safety (launder overflow prevention)

The design is such that if the launder level were to exceed a preset setpoint, the output to the hydraulic proportional valve is zero (4 mA), thereby disabling the furnace tilt. If the launder level sensor fails, there is a high level proximity switch on the sensor mechanism which detects an abnormally high level in the launder causing the hydraulics to be disabled from tilting further, whether the system is in automatic or manual. The high level proximity switch will override all tilting actions when it is "made". This minimises the possibility of metal spill from the launder, previously no such safety feature was installed.

f) Gain an understanding of the process

With the function of real time displays (trending, histograms, etc.) and data capture a basic understanding of the process can be attained and evaluated and a course of action taken to improve the system.

5.0 SCOPE

5.1 Stage 1

- Install a weir in the launder
- Install launder level control
- Weir actuation to be by operator

Crucial to achieving good ingot consistency is the maintenance of a consistent head of metal behind a weir in the launder.

Installation of a weir also has the benefits of allowing the furnace tilt and launder level control to be a closed loop i.e. not acted upon by the operator and the cast speed to be maintained. Currently the cast speed is reduced near the end of a cast as metal flow decreases i.e. it is easier to control the belt speed than the furnace tilt to maintain ingot consistency.

The furnace tilt is governed by the launder level (irrespective of the weir position). Once a constant launder level is obtained and the weir position set for a fixed flow, only minor cast belt speed adjustments at the start of the cast need to be made by the operator to obtain the desired ingot size, see Fig.2.

5.2 Stage 2

- Install ingot height measurement system
- Automate weir or belt speed control

Install an ingot height measurement and display system. This has the advantage of displaying ingot height and trending information to the operator/supervisor with the facility to record cast data for supervisor/operator or technical evaluation of the process, see Fig.3.

The ingot height information is also used in the feedback loop to automatically control the actuation according to ingot height. The system will then be a closed loop, (i.e. system actions will be met with system reactions) requiring minimal operator interaction.

5.3 Stage 3

- Install new tap hole flow control device in No.7 furnace.

The liquid metal flow to the casting machine is controlled by a motorised regulating bar assembly, see Fig.2.

To ensure accurate control over the full range of metal flow, a special refactory tap-out block with a replaceable nozzle insert is incorporated into the furnace refractory lining.

The control device mounting bracket is attached to the side of the launder casing and incorporates the following:

- regulating bar guide system
- activating lever assembly
- manual emergency override lever
- electric actuator

The regulating bar assembly consists of an adjustable round bar with a graphite cone fitted to the lower end to enable control of the metal flow. A counterweight is fitted to the top end to ensure accurate positioning during the operation.

To ensure good sealing of the furnace tap hole nozzle when not casting, a separate manual stop bar assembly is used. A ceramic fibre cone is fitted over the graphite plug on the stop bar assembly.

Automatic control of the electric actuator is by means of the launder float control system developed in Stage 1.

6.0 CASTING SYSTEM OVERVIEW

6.1 Launder Level Control

6.1.1 Furnace Tilt Control

The discharge of molten aluminium from the furnace must be regulated in order to maintain a constant flow to the casting belt.

The furnace tilt is controlled by means of a feedback loop from a capacitance sensor in the discharge launder. The capacitor sensor indicates the metal level to the PLC. The PLC using this input signal, actuates a proportional valve which controls the supply of hydraulic fluid to the lifting rams. Fluid is supplied to the rams until the metal reaches the desired launder level setpoint, where upon the flow is inhibited.

This is a PID controller designed to maintain a constant head of metal in the discharge launder.

6.1.2 Molten Metal Flow

Despite maintaining a fixed head of metal in the launder, flow fluctuations from the furnace do occur when tilting. A secondary flow control device regulates this flow of metal from the launder into the tundish.

The secondary flow control device comprises of a weir situated such that the metal flows beneath it, (as underpour to minimise dross formation).. The height of the weir was controlled by the operator in stage 1 and automatically controlled by the ingot height measuring system in stage 2. With a regulated flow from the launder it is possible to control the metal level in the moulds by weir actuation.

6.2 Ingot Height Measurement Control System

6.2.1 Molten Metal Height Detection

Molten metal height in each mould is measured by a capacitance level sensor positioned above the moving casting belt, and close to the skimming operator. As the mould position in the belt can vary vertically the metal height is expressed relative to a reference point on that mould i.e. the mould hinge. As the moulds are continuously moving under the capacitive sensor a snap shot of the height of the mould hinge is taken when it is directly under the sensor. Similarly the level of the molten metal at the centre of the mould is achieved by taking a snap shot. With a fixed ingot mould size, and subtracting the height of the metal from the height of the hinge a corresponding ingot height is achieved. The ingot height is averaged for a sub group size of 3 moulds (selectable 1-4). A point, representing the running sub-group average of the last 3 ingots, is then automatically plotted on a VDU trend display.

Accurate real time data can thus be used with confidence by the operator to maintain ingot height uniformity through out the cast.

7.0 PROCESS CONTROL INSTRUMENTATION AND MECHANISMS

The development of this project comprised 3 stages:

7.1 Stage 1 (Furnace tilt control loop)

Development of PLC Software for Furnace No.6 Launder Level Control

The program developed controls all actions of the tilting furnace from temperature to doors and primarily an automatic/manual tilt control. The tilt automatic tilt control is basically a PID loop, the process variable being the actual launder level the setpoint determined by the operator and the output the signal to the hydraulic proportional valve

Installation of:-

7.1.1 Retrofit Of PLC 2 to PLC 5

The Allen Bradley PLC 2 utilised on the furnace was unsuitable for the proposed application due its limited maths capabilities (no PID or floating point maths facilities) and poor networking and programming features, and was therefore replaced completely utilising an Allen Bradley PLC5 controller

7.1.2 Hydraulic Proportional Valve Controller

The hydraulic proportional valve (Hydraulic Controls) and controller is used to tilt the furnace at a variable rate. Actuation of the valve is via a 4-20mA signal from the PLC, which is fed into an amplifier card for a variable voltage output signal to the proportional valve.

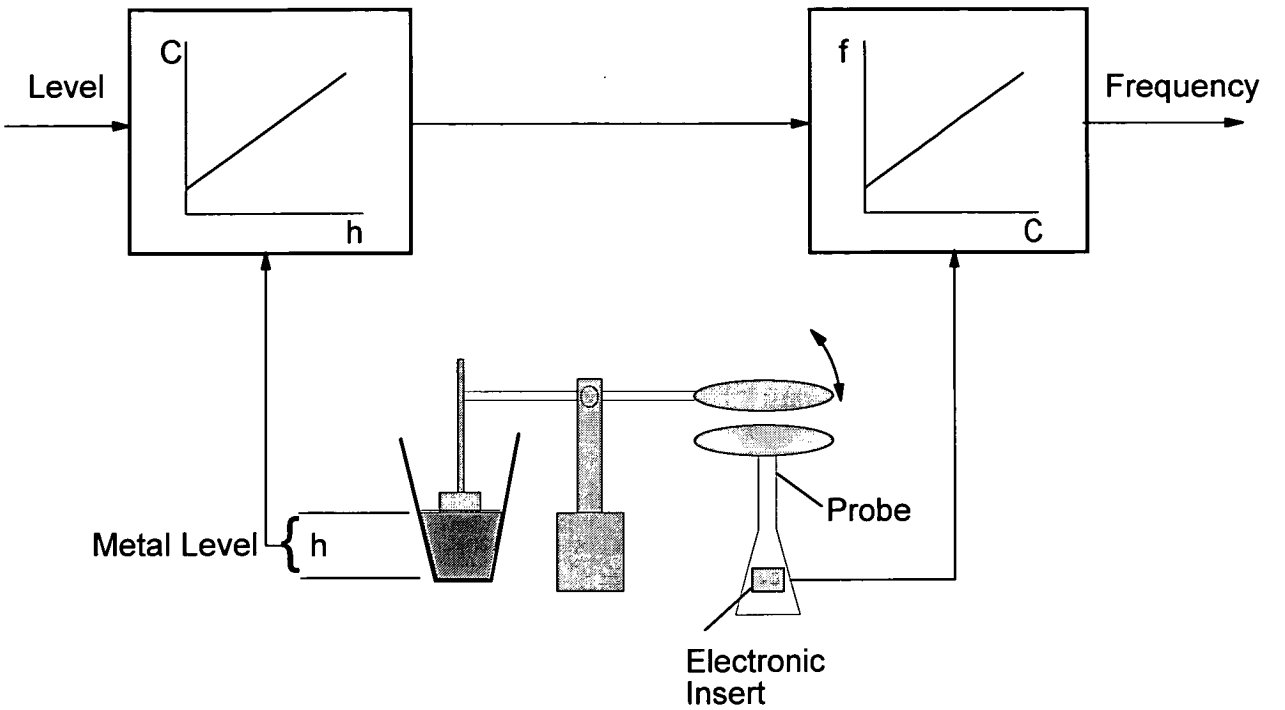


Figure 4. Capacitive Launder Metal Level Measurement

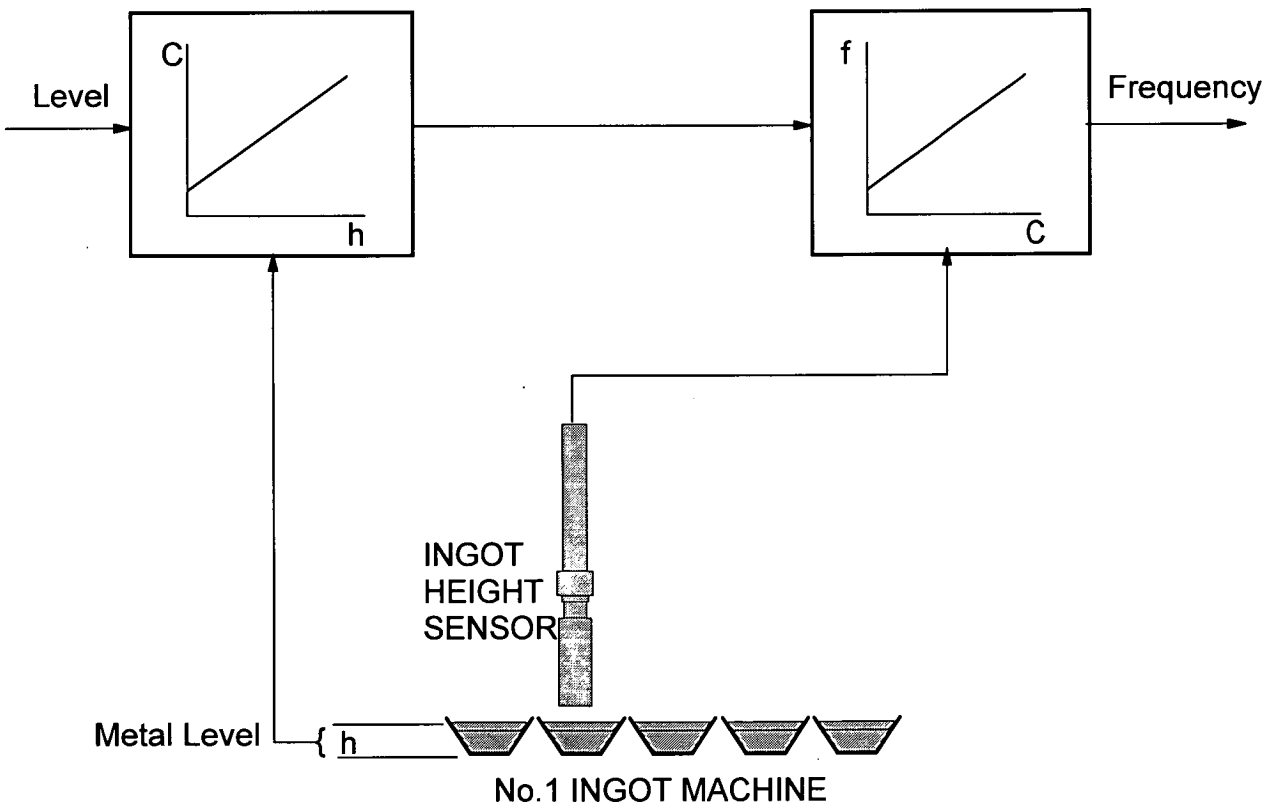


Figure 5. Capacitive Ingot Metal Level Measurement

7.1.3 Launder Level Sensor

The Launder level sensor comprises of a capacitive sensor (Endress & Hauser) with a large disc fitted to a probe, and fixed permanently to the launder steelwork. A float, pivot arm and steel disc make up the moving section of the sensor. As the launder level increases the gap between the two steel plates decreases and the capacitance increases. An insert within the probe converts the signal from capacitance to frequency. A separate controller converts this frequency to 4-20mA signal corresponding to the launder height. Scaling of the launder level is carried out within the PID instruction.

7.1.4 Operator Controlled Weir Via a Motorised (Variable Speed) Drive

A variable speed drive (Allen Bradley) in association with a 3 phase, 415V, 0.75kW motor and 15:1 gearbox ratio is used as the actuator for the weir. The weir actuation for fast, slow, raise and lower presets are setup within the variable speed drive. All control commands (Fast, Slow, Raise and Lower) are directed through the PLC and then output to the variable speed drive.

7.2 Stage 2 (Ingot height control loop)

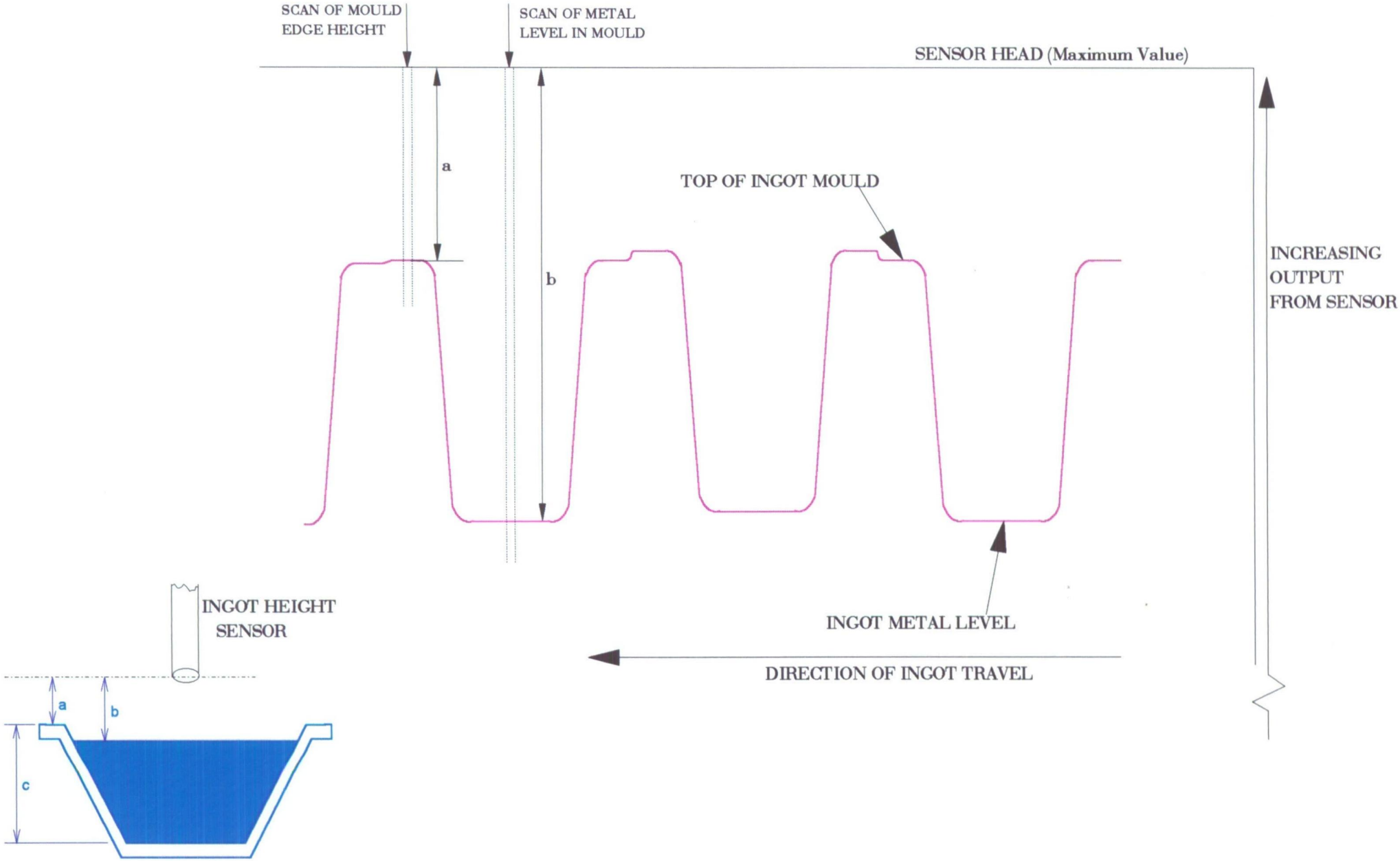
7.2.1 Installation of Ingot Height Sensor.

The ingot height sensor (Delavan Hot Prox 620) is a capacitive sensor used to measure the molten metal level in the moulds. It is a capacitance sensor, designed to measure changes of capacitance to earth as they occur. The molten metal surface and the mould edge act as earthed plates similar to one plate in a parallel plate

capacitor. The sensor being the other plate. Any change in level would appear to the sensor as a change in distance between the plates. The resultant change of capacitance will vary the frequency of a variable oscillator located in the pre-amplifier in the rear of the sensor. The frequency signal is transmitted to the converter and converted to a voltage. Within the recommended ranges the output voltage (or current) will be linear and proportional to the distance changes. The sensor measuring plate is guarded to prevent false signals from other objects or surfaces not in the desired sensing area.

7.2.2 Development of PLC Software for Ingot Height Measurement and Automated Weir Control

Snapshots are taken of the height of the mould hinge as it passes under the sensor and again at the centre of the ingot. The height of the hinge is subtracted from the height of the molten ingot, the difference is then subtracted from the total height of the mould, to yield the actual ingot size see Fig.6. A running average of the size of the most recent ingot and the two preceding (sub-group of 3 ingots) it, is calculated to obtain a value for comparison with the setpoint see Fig.7. A sub-group of 3 was selected to minimise tampering and overreaction of the system due to delays in the process, i.e. definite trends are obtained and reacted to by the controller. Controlling to each individual ingot height resulted in higher standard deviations about the 980kg setpoint. The sub-group however is user selectable from 1-4 ingots. The location of the sensor relative to the position of the weir is approximately 5 ingots or 30seconds. Therefore when the PLC has



INGOT SIZE = c - (b-a)

Dimension c = 100 mm

Fig.6 Real Time Display of Sensor Output

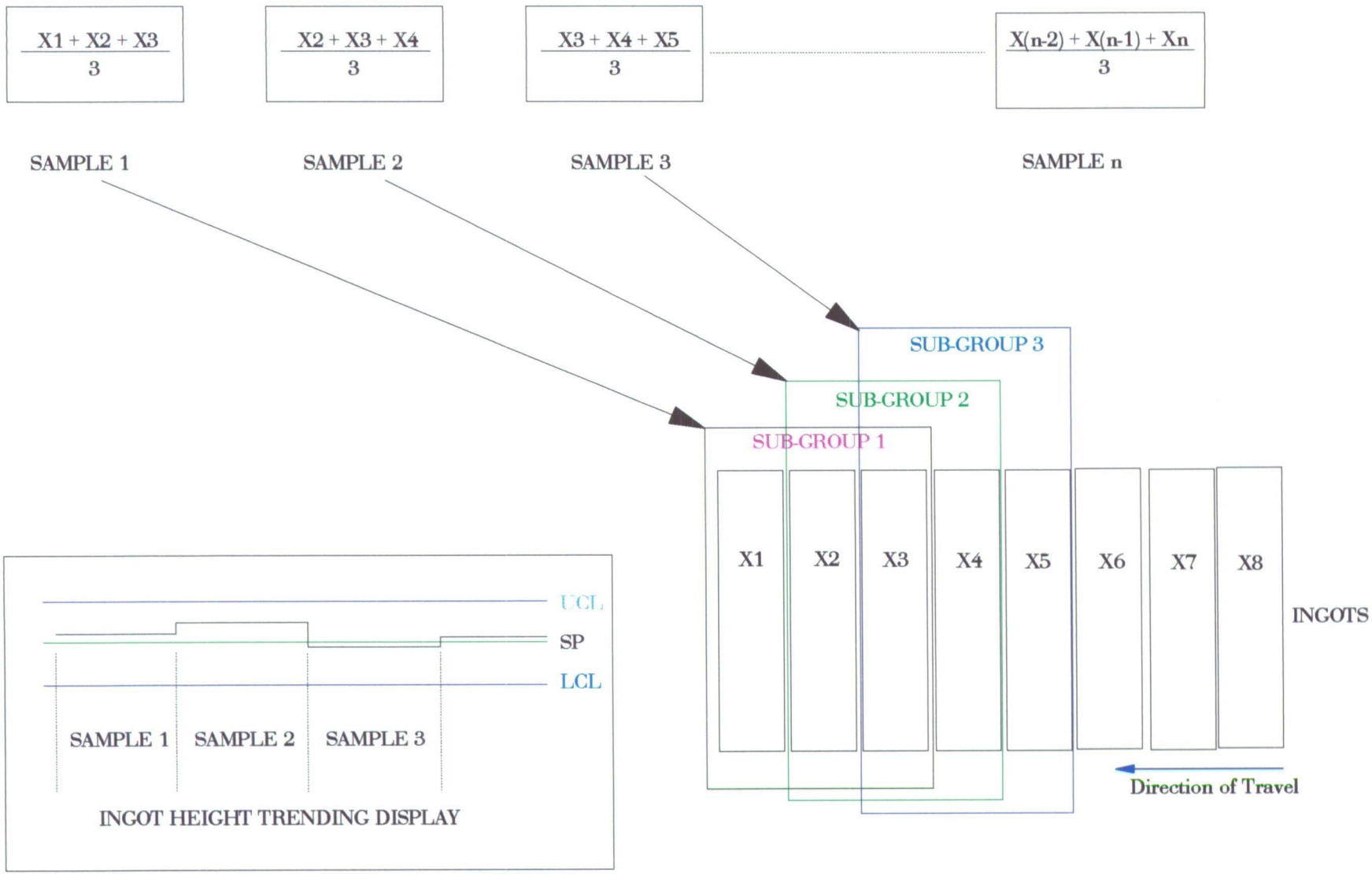


Figure 7 INGOT HEIGHT CONTROL - SAMPLE DETERMINATION

called for the weir to raise/lower the consequences of this action (in terms of increased/decreased metal flow) will only be seen by the sensor some 30 seconds later, the system will then measure the height of the next two sub-groups i.e. another 12 seconds, the result is a delay of 42 seconds before the system will make a change to the weir position again. Once the sub-group average height has been determined it is compared with the ingot height setpoint (80mm or 91% of mould capacity) see Figs. 8, 9 & 10. There is a deadband around the setoint of 2% , where there is no action taken by the system. If the process variable PV (ingot height) is 93%<PV<94% for longer than 50 seconds the weir will be lowered down for a .12 second pulse. If the PV>94% for 50 seconds the weir is lowered down for a pulse of .14 seconds. If the process variable PV (ingot height) is 87.5%<PV<89% for longer than 50 seconds the weir will be raised up for a .12 second pulse. If the PV<87.5% for 50 seconds the weir is raised up for a pulse of .14 seconds, see Fig.11 & 12.

An improvement to the system would be to relocate the sensor adjacent to the tundish to minimise delays in the system.

Development of computer software designed to extract ingot height information (and any other relevant cast data) from sensors for display and technical evaluation. Data for each cast is archived to the computer through the Citect software. The ingot heights, launder levels and cast speed are recorded for each cast automatically when the cast is in progress.

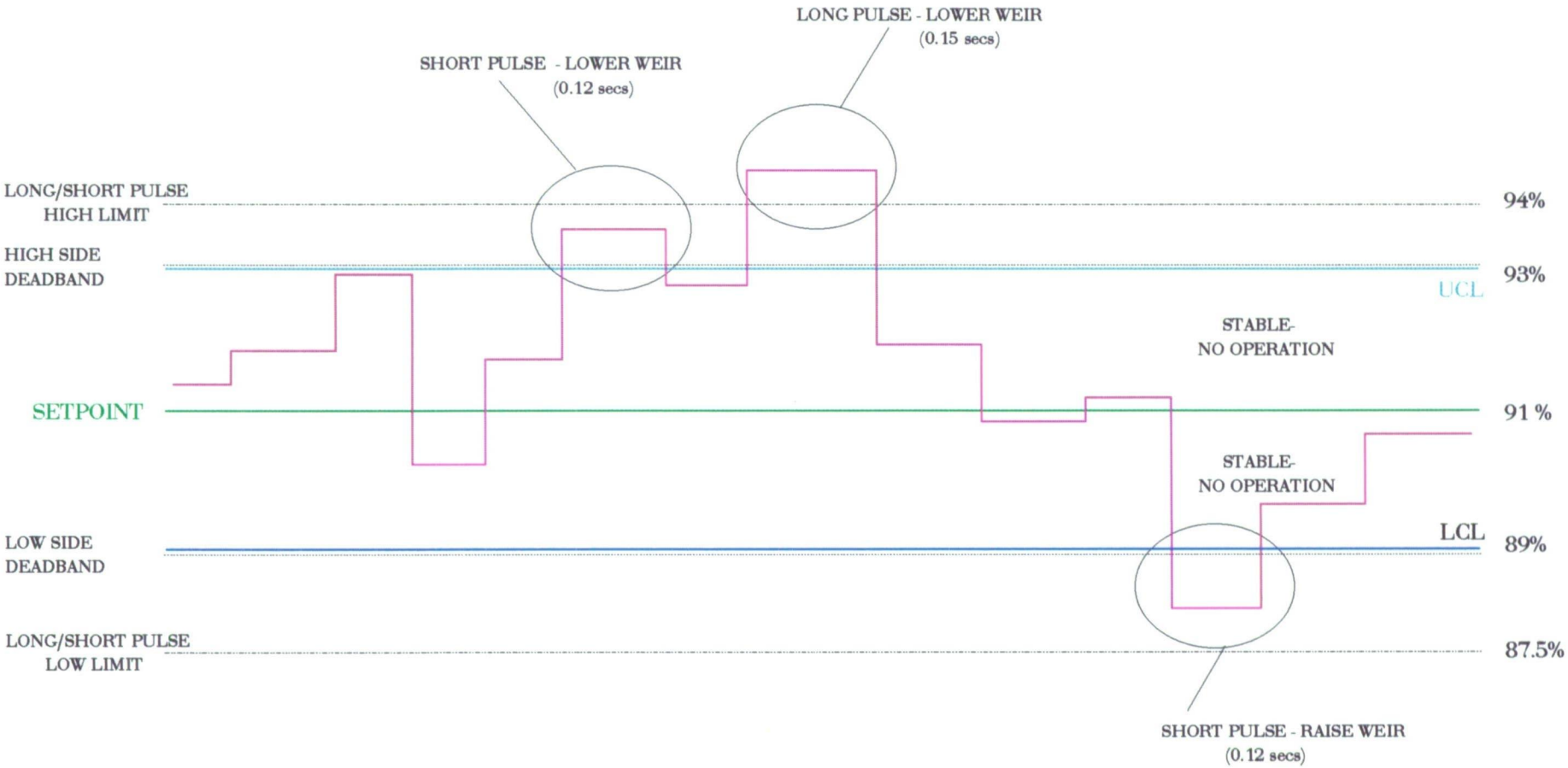


Figure 8 INGOT HEIGHT CONTROL - TRENDING

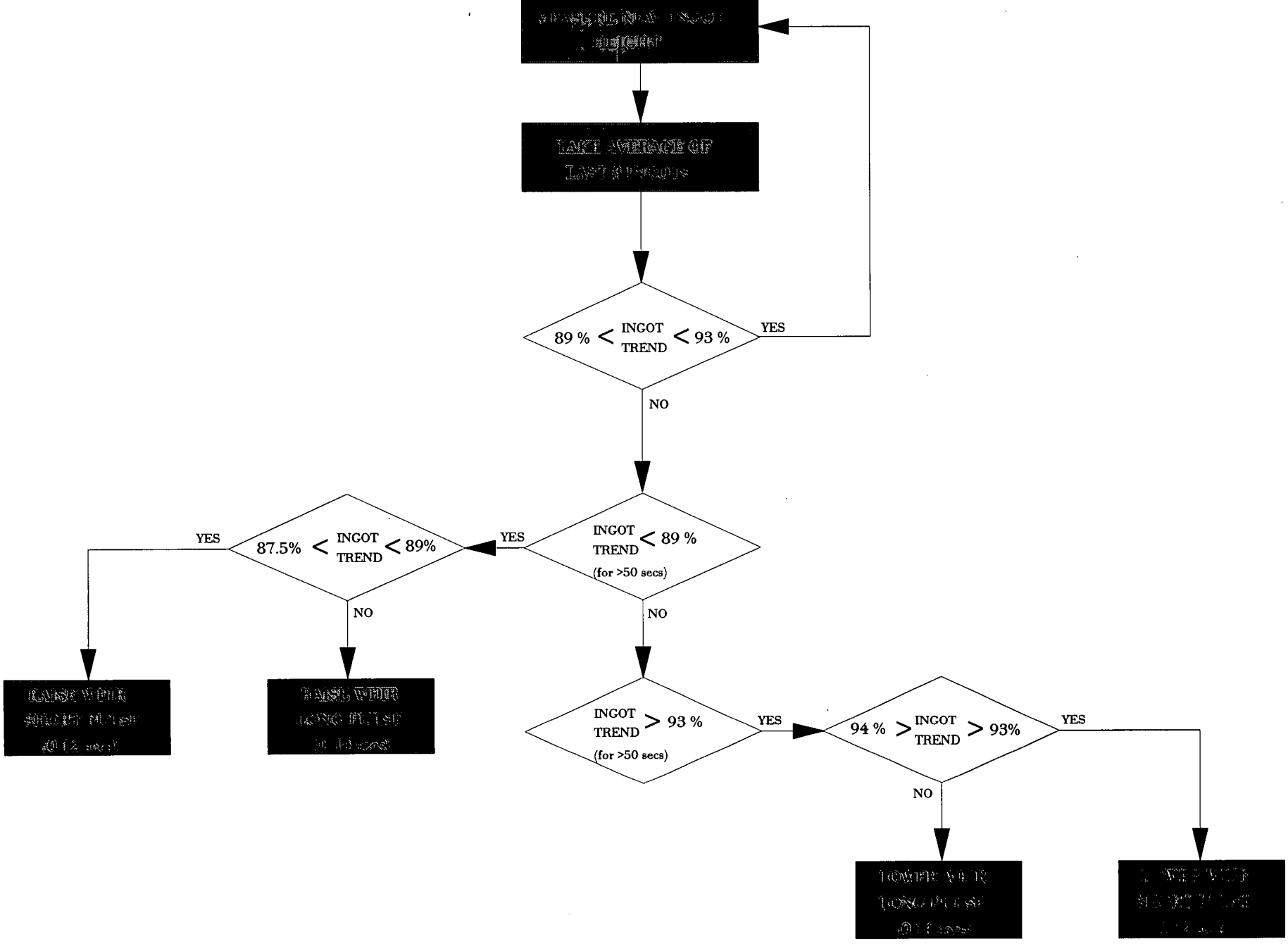


Figure 9 INGOT HEIGHT CONTROL - FLOWCHART

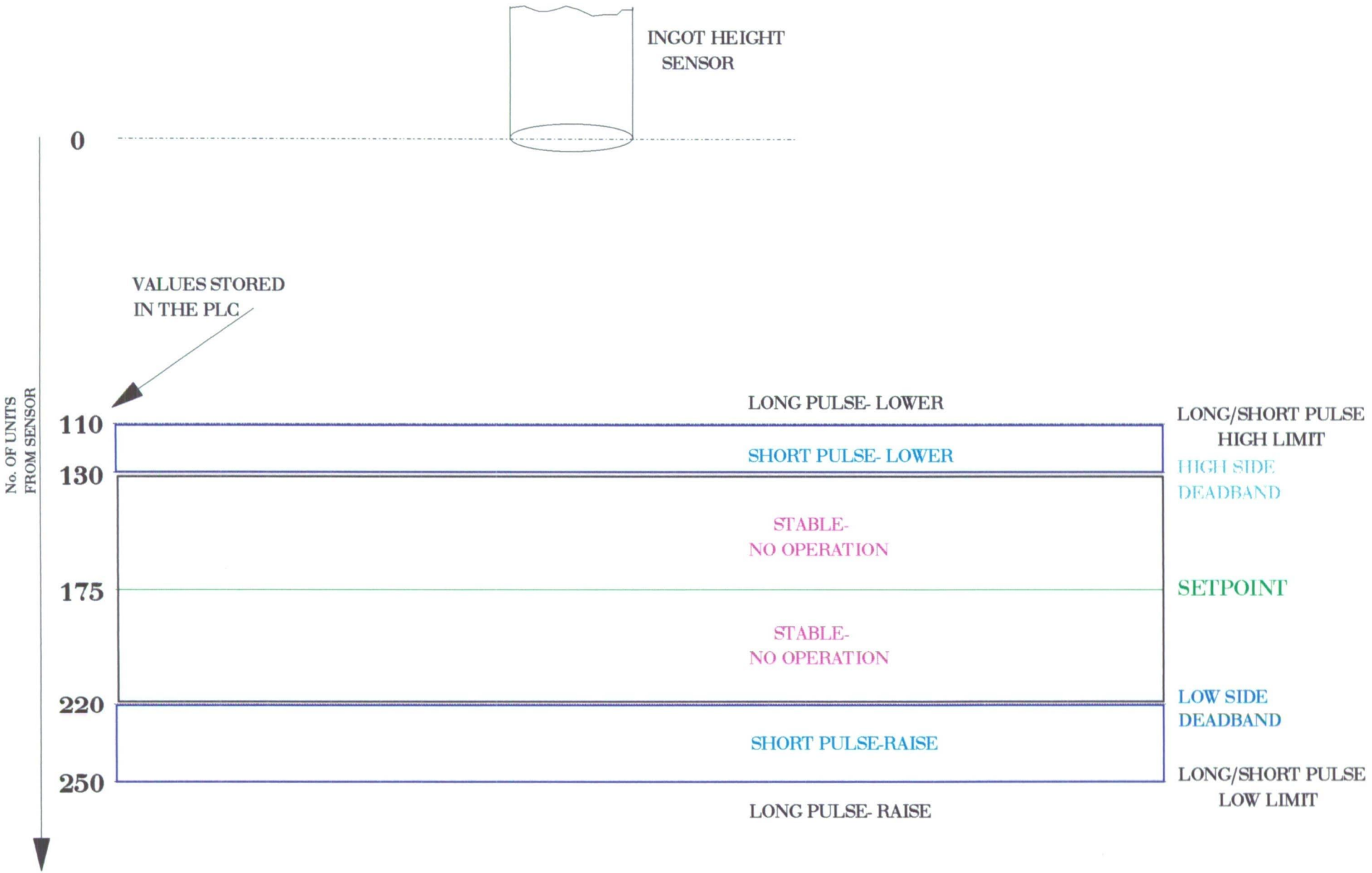


Figure 10 INGOT HEIGHT CONTROL - PLC ADDRESS VALUES

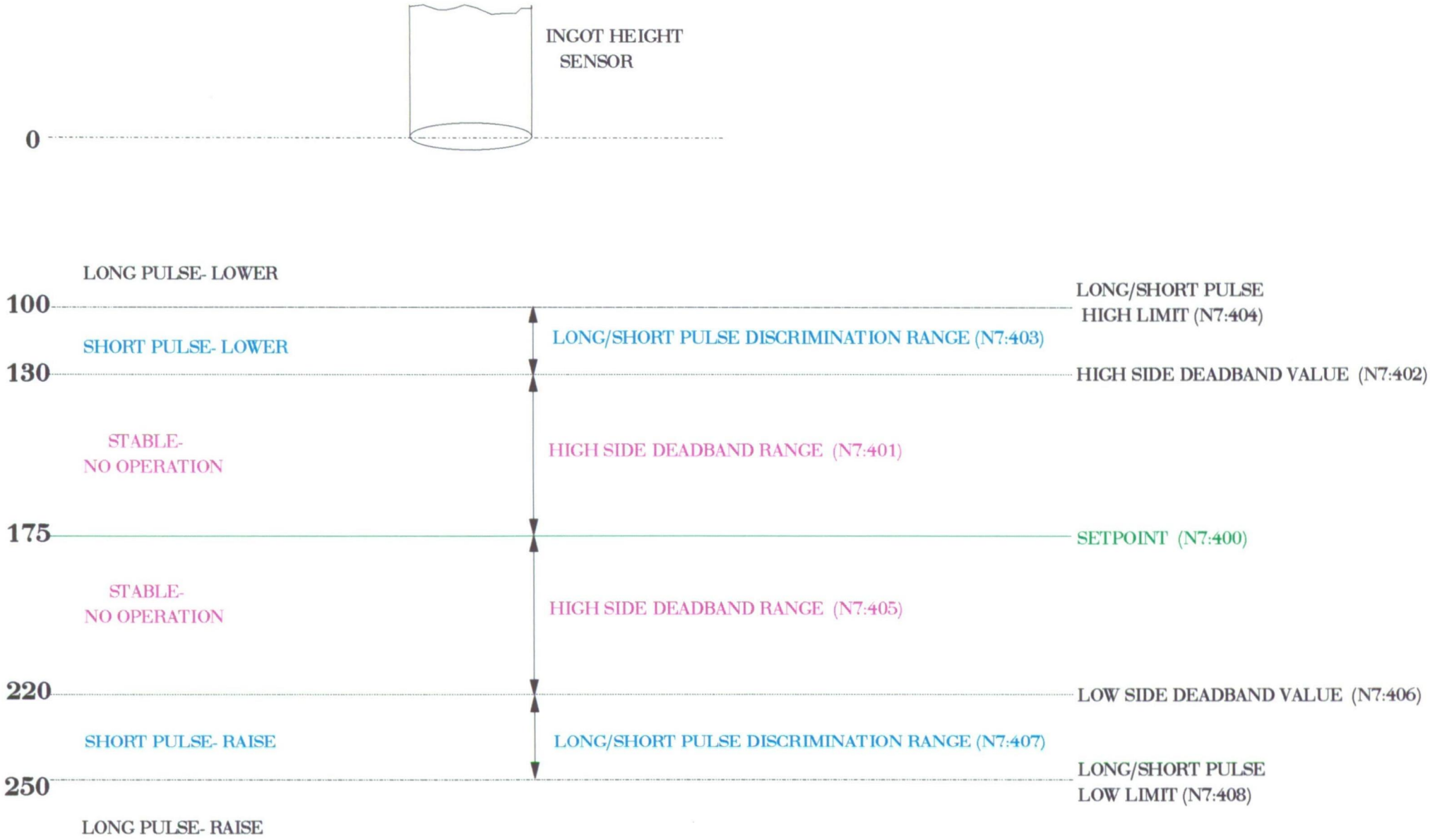
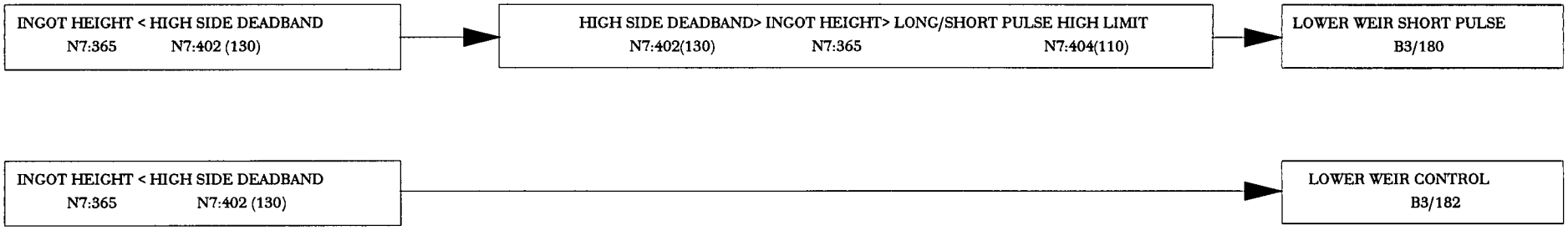
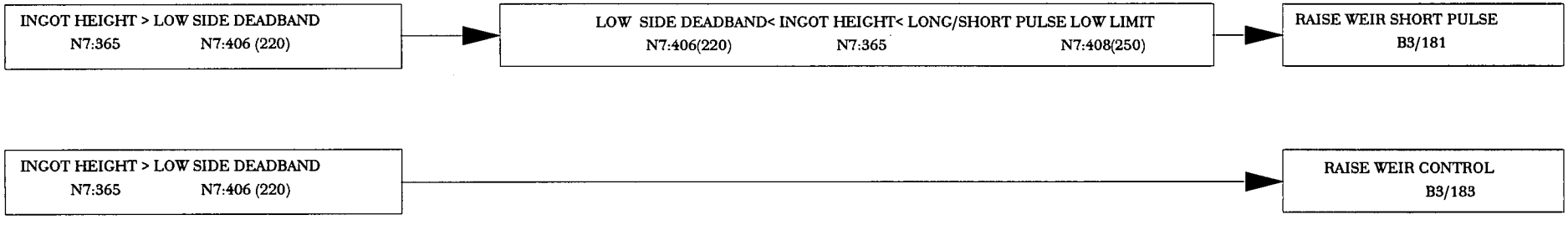


Figure 11 INGOT HEIGHT CONTROL - PLC ADDRESSES



METAL FLOW DECREASE CONTROL



METAL FLOW INCREASE CONTROL

Figure 12 INGOT HEIGHT CONTROL - WEIR CONTROL

7.3 Stage 3 (Furnace tap-hole control loop)

Development of PLC Software for Furnace No.7 Tap Hole and Launder Level Control.

Utilising the launder level control system sensor, developed in stage 1. The electric actuator installed relies on pulse duration to determine how far the tap hole plug is moved into or out of the tap hole, 2 contacts determine in which direction the actuator operates. The same control philosophy as stage 2 is utilised, whereby the launder level process variable is compared to the launder level setpoint, and depending on the error between the two determines the movement of the actuator. A recognised problem with this facility is the location of the tap hole relative to the launder, the tap hole is above the metal level in the launder where it is prone to freezing of the metal. Such freezing causes non repeatability in the system, the result is an improved metal flow but not consistent enough to maintain metal levels to the accuracy of the tilting furnace. An improvement to the system would be to locate the tap hole so that it is submerged in the launder metal, the graphite material of the tap plug lends itself to this type of application.

7.4 Stage 4 (Data integration - Under Investigation)

Full integration of software with Metal Products proposed data aquisition/supervisory control system, to provide multiple user access to historical data for statistical analysis.

Possible integration with the Metcon system. Metcon is mainframe based program used to audit the amount of metal which enters the casting shop as molten metal and what leaves the casting shop as product.

8.0 SOFTWARE DEVELOPMENT

8.1 Stage 1 Launder Level Control Software Development

To enable the technical evaluation of the launder level sensor to proceed and to identify how it may be best utilised, it is necessary to develop PLC and computer software capable of capturing the sensor data and to perform basic statistical calculations and display functions. See Files 4,7,8 PLC program listing.

8.2 Stage 2 Ingot Height Control Software Development

The second stage of software development allows for full automation of the metal flow i.e. launder and ingot height control, see Files 8,10,12 PLC program listing.

Also available is the facility for operator and supervisor access. It is envisaged that provision be made for the operator to key in the cast number and for data acquisition to be automatic once molten metal appears in the moulds (Metcon System).

The software provides the supervisor/operator with an option to view a whole cast at the completion that cast. This will provide instant feedback of the systems ability to control ingot size, see File 13 PLC program listing.

All data storage and display options are accessed from a keyboard via an industrial computer. Data may be backed up and archived to floppy disk, or printed for later analysis.

8. 3 Stage 3 Furnace Tap Hole Control Software Development

Utilising the launder level signal as an input to a control loop to determine actuation response for the tap hole flow control. A variable pulse otuput to the actuator is used to determine how far it is moved and a direction signal, see File 11 PLC program listing.

8.4 Stage 4 Data Integration Software Development

The final stage of software development will be to fully integrate the control system with the Metal Products Data Aquisition/Supervisory Control system.

Data may be backed up and archived on a VAX providing the facility of data retrieval and display from all terminals connected to the network.

The facility of integrating the cast information to Metcon (if this facility is required) is currently under investigation.

9.0 INGOT HEIGHT SENSING

9.1 Description

Molten metal height in each mould is measured by a capacitance level sensor positioned above the casting conveyor. As the mould position in the conveyor can vary vertically the metal height is expressed relative to a reference point on that mould i.e. the edge of the mould. The metal height is averaged over a sub-group size of the last three moulds. The latest sub-group value is then plotted on the ingot height trend chart.

Under normal automatic operation if the trend goes out of the defined limits for 45 seconds the weir is automatically raised/lowered to increase/decrease the metal flow as required to bring the system back in control. The amount the weir raises/lowers is dependent on how far the trend is from the setpoint.

9.2 Principle of Sensor Operation

A Delavan Hot Prox 620 model CNR 200 is used to measure the molten metal level in the moulds. It is a capacitance sensor, designed to measure changes of capacitance to earth as they occur. The molten metal surface and the mould edge act as earthed plates similar to one plate in a parallel plate capacitor. The sensor being the other plate. Any change in level would appear to the sensor as a change in distance between the plates. The resultant change of capacitance will vary the frequency of a variable oscillator located in the pre-amplifier in the rear of the sensor. The frequency signal is transmitted to the converter and converted to a voltage. Within the recommended ranges the output voltage (or current) will be linear and proportional to the distance changes. The sensor measuring plate is guarded to prevent false signals from other objects or surfaces not in the desired sensing area.

9.3 Sensor Output

A maximum and minimum is associated with each ingot measured.
For Control purposes in the software the maximum represents the surface furthermost away from the sensor (the molten metal surface), the minimum represents the closest surface (the mould edge).

However the raw input from the sensor is vice versa i.e. the maximum represents the surface closest to the sensor (the mould edge), the minimum represents the further most surface (the molten metal).

10.0 INSTALLATION & OPERATION OF SENSOR &TRANSMITTER

10.1 Specifications

Input Voltage	240 VAC Nominal
Power/Frequency	10 Watts, 50 Hz
Operating Temperature:	Transmitter +5°C to 50°C
Cooling Sensor:	+ 94°C Maximum (pre-amp), forced air of instrument quality required. Requirements vary but supply must be adequate to maintain internal temperature below 94°C
Output Signal:	0-10 VDC (optional -5V to +5V and 4-20mA)
Time Response:	1 millisecond to 1000 milliseconds in 4 steps
Cable Length:	6 metres, 6 conductor 150°C service temp
System Drift:	100 minutes from room temperature to full heat 800°C process
Measured Drift:	± 0.00127 mm/hour
Measuring Range:	
Sensor Size:	50.8 mm
Maximum Range:	178 mm
Stability:	+ 0.05mm at 12 mm from Sensor
Deviation:	1 % from 9.52mm to 76.2mm

10.2 Mechanical and Electrical Installation

Sensor Mounting:

10.2.1 The CNR Sensor uses 1-1/2" Pipe for mounting. This pipe is used to conduct air cooling to the sensor as well as contain the sensor cable.

10.2.2 Fasten the cable connector to the pre-amp by rotating the knurled fitting clockwise. (Note: That the connector has a keyway locater.) This connection should be finger tight, do not use a tool.

10.2.3 Connect Black wire from cable to internal ground lug located in 1-1/2" nipple.

10.3 Air Cooling Sensor:

Where the sensor is located it is exposed to elevated temperatures and it must be cooled by purging with air. Maximum pre-amplifier temperature is (94°C).

10.4 Temperature Sensor

An AD 590 Analog Device integrated circuit temperature transducer is potted into the sensor pre-amp. The range of this sensor is - 55°C to + 150°C with an output of 1 microamp/0 K. Terminal connections are located in the CR/85 Transmitter housing. This sensor is useful in determining the exact amount of purging air required to cool the pre-amplifier to LESS than 94°C.

11.0 SENSOR ARM

There are two major actions in the sensor arm designed, as safety features to prevent sensor damage.

11.1 The first is a hinge pin and bracket in the vertical plane. This allows the sensor to be swung to the conveyor side during maintenance.

11.2 The second consists of a pivot plate, which allows the sensor to pivot when contact is made. The sensor can only pivot in the same vertical plane as the direction of the casting conveyor. Once the obstruction has passed the sensor will pivot back to its original position automatically.

The sensor (pre-amplifier) cannot be exposed to temperatures in excess of 95°C. To ensure the sensor temperature is maintained below this level, compressed air of instrument quality is forced into the sensor arm and hence through the sensor thereby cooling it.

The braided tube is the air line.

The Anaconda conduit contains the sensor- transmitter cable.

See Comalco Drawing 21556

12.0 OPERATION

This section contains the calibration information for the Hot Prox/620 system utilising the CR/85 transmitter and the CNR 200 sensor.

12.1 Calibration /General

The controller outputs consist of 4-20mA loop, and a 0-10 volt or -5 to +5 volt output. All of these may have a positive slope called "Normal," or a negative slope called "Reverse." The output used on the Ingot Height Sensor is "Reverse." The Controller output utilised is 0-10 volts.

12.2 Calibration/Reverse Operation:

An increase in capacitance causes an increase in voltage (or current), i.e. a reduction in distance between sensor and subject causes an increase in output.

12.2.1 Set output switch to reverse position.

12.2.2 For voltage output instead of current , set "volts range" jumper to 0-10 volts or -5 to +5 volts as needed. The 4-20mA output is always energised.

12.2.3 Using a small screwdriver, set controls as follows:

OFFSET:	OFFSET Switch to ZERO Position
SPAN:	All Switches CLOSED
RESPONSE TIME:	Switch #1 CLOSED, Switch #2,3,4 OPEN

12.2.4 Unlock OFFSET and SPAN potentiometers located on panel face by moving the small lever on each potentiometer counter clockwise to WHITE dot. Turn both potentiometers fully clockwise.

12.2.5 Set the shortest desired distance, ground-plane to sensor. Monitor 0-10 volts output:

A) Output is LESS than 10 Volts.
Set "OFFSET" switch to "POSITIVE."

B) Output is GREATER than 10 Volts.
Turn "OFFSET" potentiometer counter-clockwise until output equals 10 volts. Lock "OFFSET" potentiometer by moving lever to RED dot.

12.2.6 Set the longest desired distance, ground-plane to sensor. Monitor 0-10 volts output:

A) Output is GREATER than 0 Volts.
Increase total number of open "SPAN" switches, one at a time until output is LESS than 0 volts.
For example: Open switch #1, then #1 and 2, then #1, #2, #3 and if necessary, open all switches.

B) Output is LESS than 0 Volts.

Turn "SPAN" potentiometer counter-clockwise until output voltage equals 0 Volts. Lock SPAN potentiometer by moving lever to RED dot.

12.2.7 Basic calibration is now complete. To set the response time, go to step 11.2.8.

12.2.8 A) Voltage (or current) output appears jittery or responds too fast:

Increase response time by closing switches 2 through 4 until output is steady.

B) Voltage (or current) output appears sluggish or slow to respond :

Decrease response time by opening switches 4 through 1 until output is responsive.

Calibration is now complete.

13.0 MAINTENANCE & SERVICE

13.1

Two Year Product Warranty:

Delavan Electronics, will replace, put in good operating condition, or purchase price refunded, at the option of DELAVAN, free of charges except transportation if defective in their manufacture or shipping, and if notice of said defect is received by Delevan within two years of shipment date.

NOTE: The location of the sensor is in an area where excessive temperatures are attainable, therefore it is necessary to ensure that the sensor is always receiving cooling air over the pre-amp. Because this is a variable not controlled by Delavan, the sensor warranty is limited. Each sensor pre-amp is marked with a temperature sensitive paint so that an individual unit can be examined to determine the exact temperature exposure. Preamp units that have experienced temperatures above 94°C will not be repaired under warranty.

Supplied locally by:

Sencon Pty. Ltd.
18 Innocent St
Kings Meadows

Telephone: 447 433
Attention : Peter Hingston.

14.0 RESULTS

	MEAN (kg)	C_p	C_{pk}	SD	Above Spec %	Below Spec %
FURNACE 6	949	0.66	0.21	22.8	0.33	27.33
FURNACE 7	939	0.54	0.05	27.5	0.29	43.43

PRIOR TO INSTALLATION OF INGOT HEIGHT CONTROL SYSTEM

	MEAN (kg)	C_p	C_{pk}	SD	Above Spec %	Below Spec %
FURNACE 6	980	0.96	0.96	15	0	0.6
FURNACE 7	963	0.89	0.56	16.8	0	4.7

INGOT HEIGHT CONTROL SYSTEM INSTALLED

Table 1 Comparison Of Before And After Ingot Height Control System Installation

Date	Mean	Cp	Cpk	SD	Above Spec %	Below Spec %
15-30 Sep 92	977.4	0.51	0.48	29.7	4.31	5.69
20-30 Nov 92	943.7	0.58	0.11	25.9	0.31	36
1-31 Dec 92	967.1	0.8	0.57	18.8	0	5.48
14-16 Jan 93	974.5	0.79	0.7	18.9	0	2.36
24-26 Jan 93	973.2	0.8	0.68	18.7	0	2.73
10-12 Feb 93	965	0.73	0.49	20.6	0	9.09
21-24 Mar 93	971.2	0.78	0.62	19.3	0	3.79

Overall - Furnaces 6 & 7

Date	Mean	Cp	Cpk	SD	Above Spec %	Below Spec %
15-30 Sep 92	975.2	0.66	0.59	22.8	1.48	2.96
20-30 Nov 92	949.1	0.66	0.21	22.8	0.33	27.33
1-31 Dec 92	973.2	0.94	0.79	16	0	2.56
14-16 Jan 93	982.9	0.95	0.89	15.8	0	0.59
24-26 Jan 93	980.3	0.96	0.96	15.6	0	0.59
10-12 Feb 93	973.5	0.93	0.79	16.1	0	2.34
21-24 Mar 93	976.7	0.91	0.84	16.6	0	0.72

Furnace No.6

Date	Mean	Cp	Cpk	SD	Above Spec %	Below Spec %
15-30 Sep 92	979.9	0.45	0.45	33.6	6.49	7.3
20-30 Nov 92	939.1	0.54	0.05	27.5	0.29	43.43
1-31 Dec 92	945.4	0.71	0.16	21.1	0	30.16
14-16 Jan 93	963.3	0.89	0.56	16.8	0	4.72
24-26 Jan 93	963.5	0.82	0.52	18.2	0	5.65
10-12 Feb 93	955.4	0.72	0.33	20.8	0	16.67
21-24 Mar 93	962.1	0.74	0.45	20.1	0	8.82

Furnace No.7

London Metal Exchange Weight Tolerance Variation
Data Analysis 25kg Ingot Bundle Weights

Launder Level Control Commissioned	1/12/92
Ingot Height Control Commissioned	11/1/93
Furnace Tap Hole Control Commissioned	11/1/93

Table 2 Bundle Weight Variations Spot Checks

INGOT WEIGHT USING AUTO CONTROL

ile	:22AUTO	Date:12-16-1992, 09:47:08	
ompany	:COMALCO (BELL BAY) LIMITED		
lant	:BELL BAY	Part name	:NO.6 FURNACE
epartment	:METAL PRODUCTS	Part Numbers	:DAY SHIFT CASTS
achine	:NO.1 M/C	Sample frequency	:EACH
peration	:ROBOT WEIGHING	Units	:KG
haracteristic	:INGOT WEIGHT USING AUTO CONTROL		

Descriptive Statistics

All (n=1)				Interval =	7.0
117 data points				mid-point	
Mean =	973.2	Min. Value =	925	Chi Squared=	3.384
Sigma Indiv=	16.0	Max. Value =	1008	deg. free. =	5
Est. Sigma =	10.4	Kurtosis =	0.041	Conf. Level=	95%
Coeff.Var. =	0.0	Skewness =	-0.352	Normal	

Capability
Using Sigma Indiv

Actual %				Theoretical %	
Above Spec =	0.00	Upper Spec.=	1025.0	Above Spec =	0.06
Below Spec =	2.56	Nominal =	980.0	Below Spec =	0.86
Out of Spec=	2.56	Lower Spec.=	935.0	Out of Spec=	0.92
Cpk =	0.79	Cr =	1.07	Z upper =	3.23
Cp =	0.94			Z lower =	2.38
Mean + 3s =	1021.4				
Mean - 3s =	925.1				

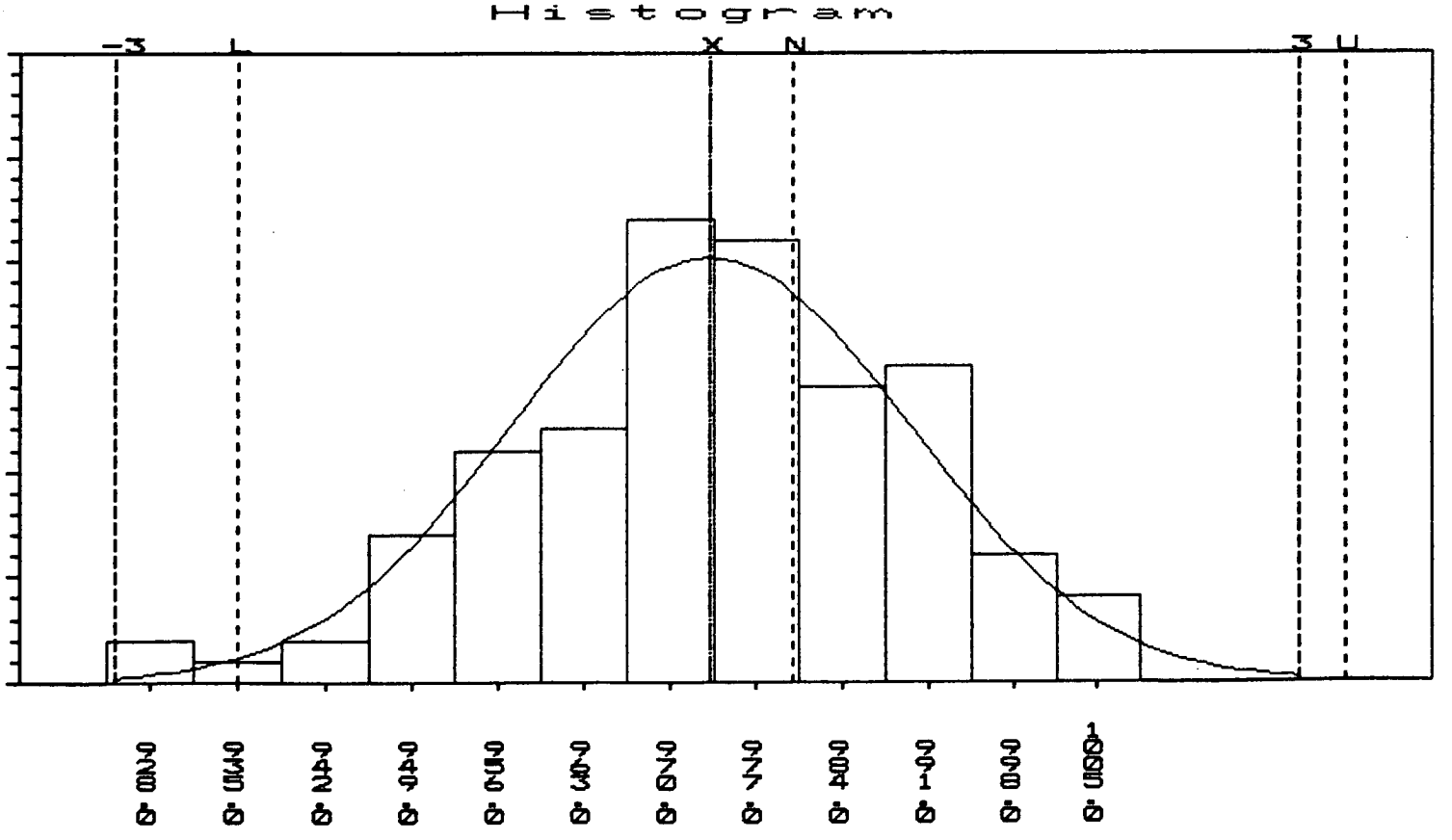


FIG.3 Distribution of Bundle Weights 16/12/92

INGOT WEIGHT NO.6 FURNACE

ile	:INGOT25	Date:02-15-1993, 10:30:06	
ompany	:PQ Systems		
lant	:BELL BAY	Part name	:
epartment	:Metal Products	Part Numbers	:
achine	:NO.1 M/C	Sample frequency	:each
peration	:Robot Weighing	Units	:kg
haracteristic	:INGOT WEIGHT No.6 Furnace		

Descriptive Statistics

1-169(n=1)				Interval =	6.0
169 data points				lower boundary	
Mean =	980.3	Min. Value =	933	Chi Squared=	6.559
Sigma Indiv=	15.6	Max. Value =	1018	deg. free. =	7
Est. Sigma =	9.9	Kurtosis =	0.055	Conf. Level=	95%
Coeff.Var. =	0.0	Skewness =	-0.070	Normal	

Capability
Using Sigma Indiv

Actual %				Theoretical %	
Above Spec =	0.00	Upper Spec.=	1025.0	Above Spec =	0.21
Below Spec =	0.59	Nominal =	980.0	Below Spec =	0.18
Out of Spec=	0.59	Lower Spec.=	935.0	Out of Spec=	0.39
Cpk =	0.96	Cr =	1.04	Z upper =	2.87
Cp =	0.96			Z lower =	2.91
Mean + 3s =	1027.0				
Mean - 3s =	933.6				

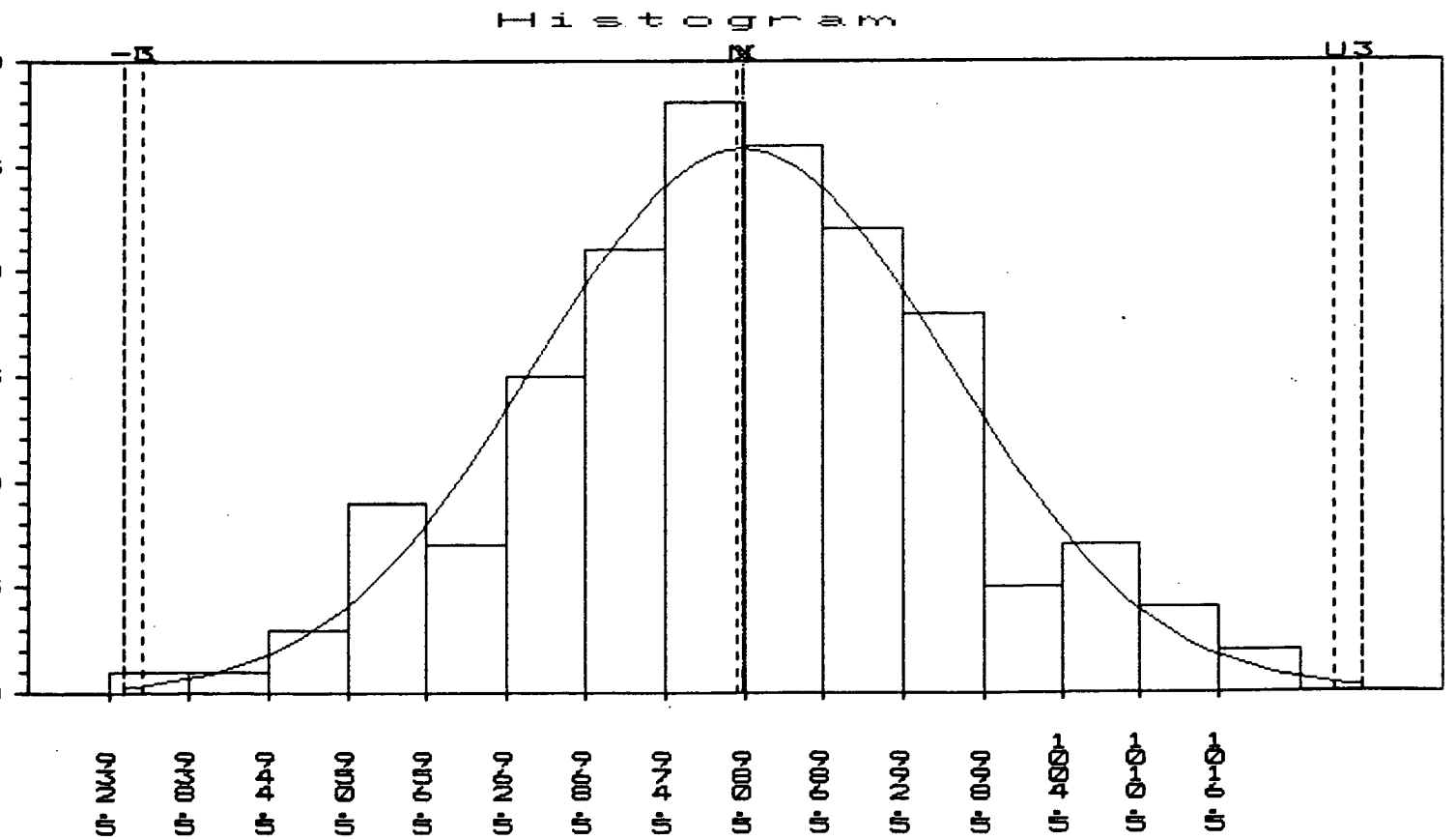
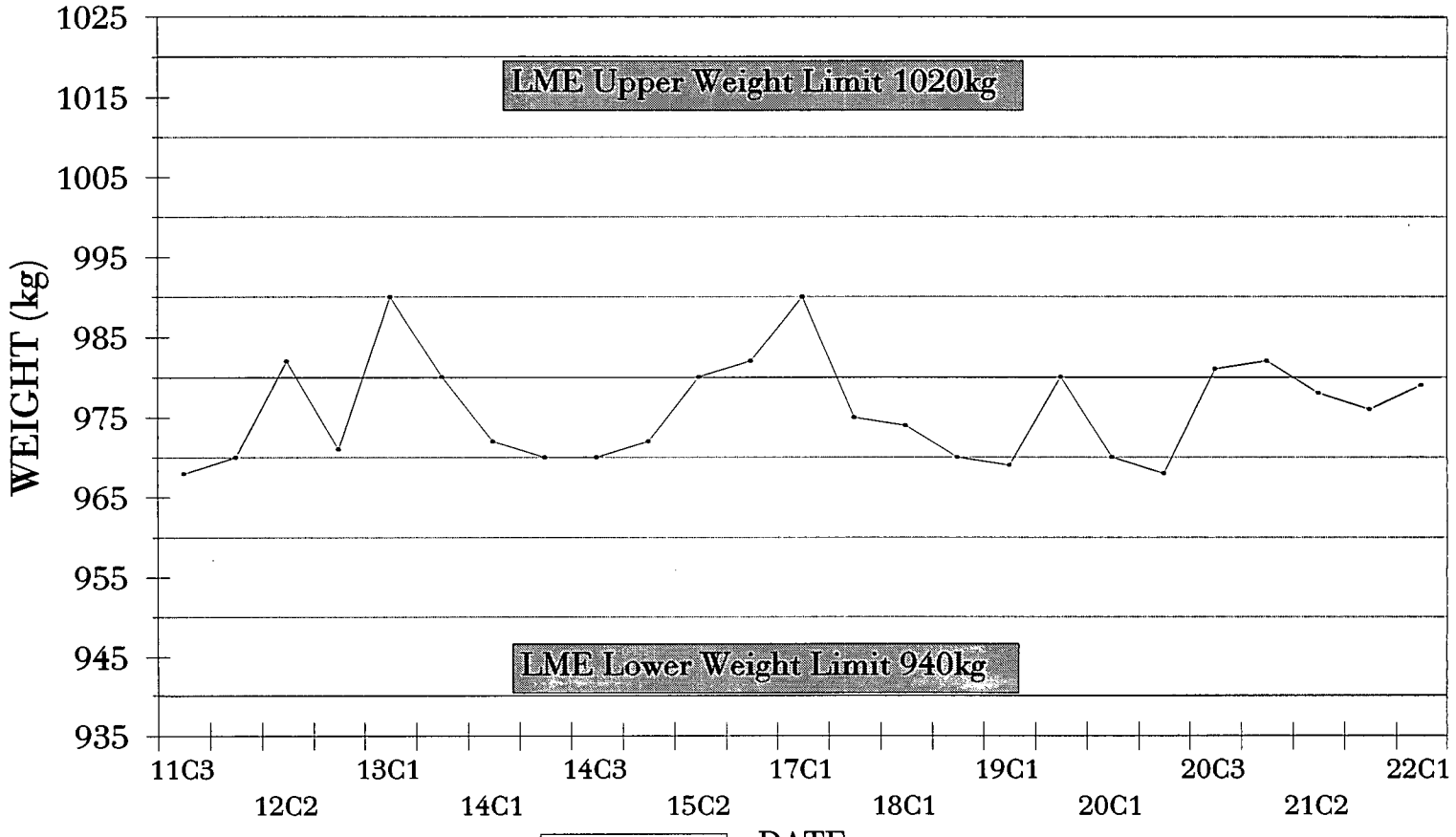


FIG.4 Distribution of Bundle Weights 24-26/1/93

INGOT BUNDLE WEIGHT VARIATION

X BAR CONTROL CHART - JUNE 1993

TARGET WEIGHT = 980kg



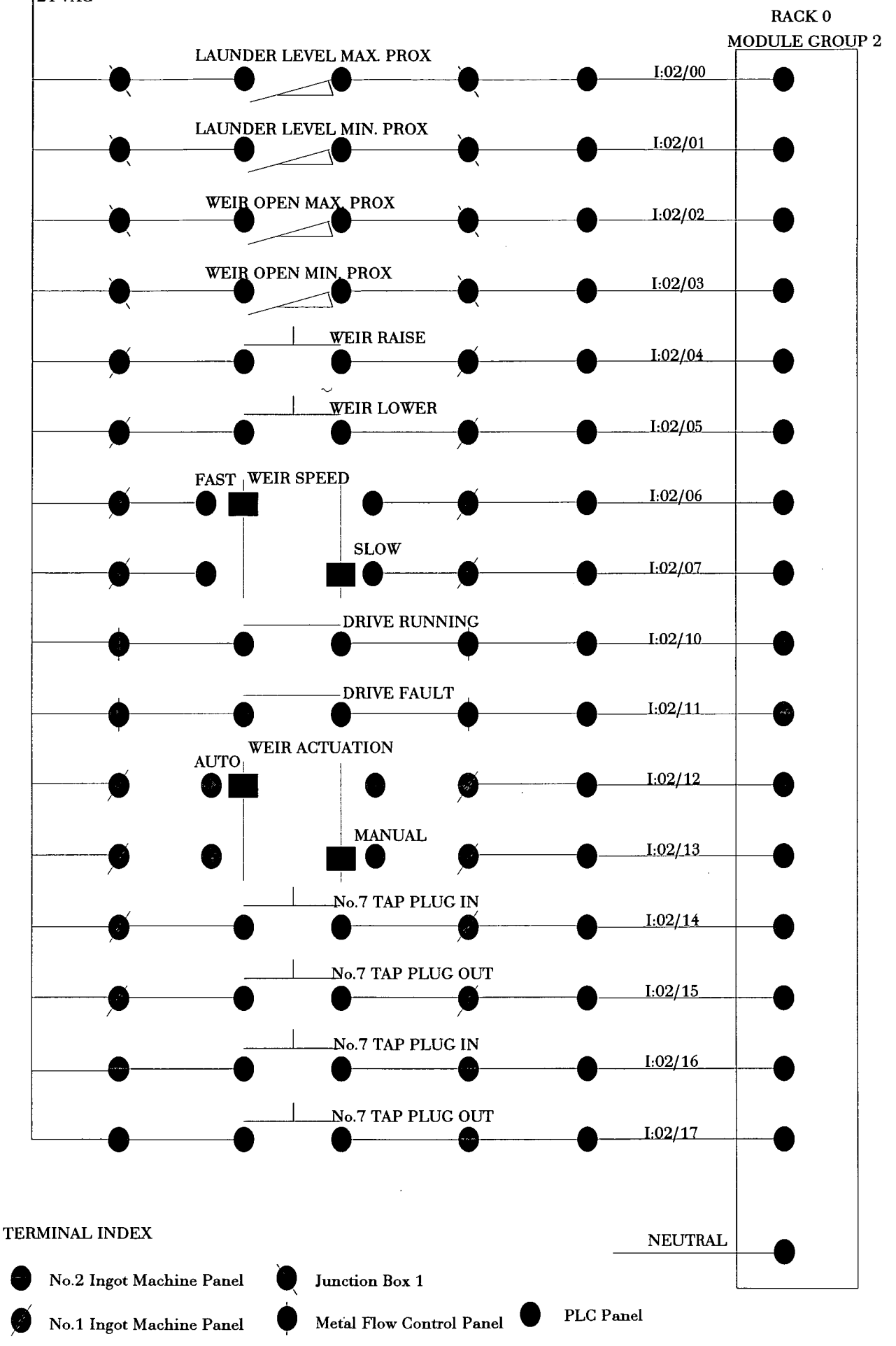
11C3 = 11 JUNE CAST 3

Figure 5

15.0 CONCLUSION

The Ingot Height Control System implemented, represents the first automated control of furnaces and ingot casting machine installed at any of the Comalco plants. The control system is to be adopted by Comalco Aluminium Boyne Smelter, utilised on a 20 tonne/hour casting machine. It is also the first time launder level control has been attempted on a fixed furnace, with encouraging results. Launder level control is now to be utilised on all furnaces in the casting shop. It is envisaged that with further modifications to the No.7 fixed furnace tap hole, and relocation of the ingot height sensor (to minimise time delays in the system), the production of any out of specification bundles will cease. The project was completed on time, within budget and performance specifications exceeded.

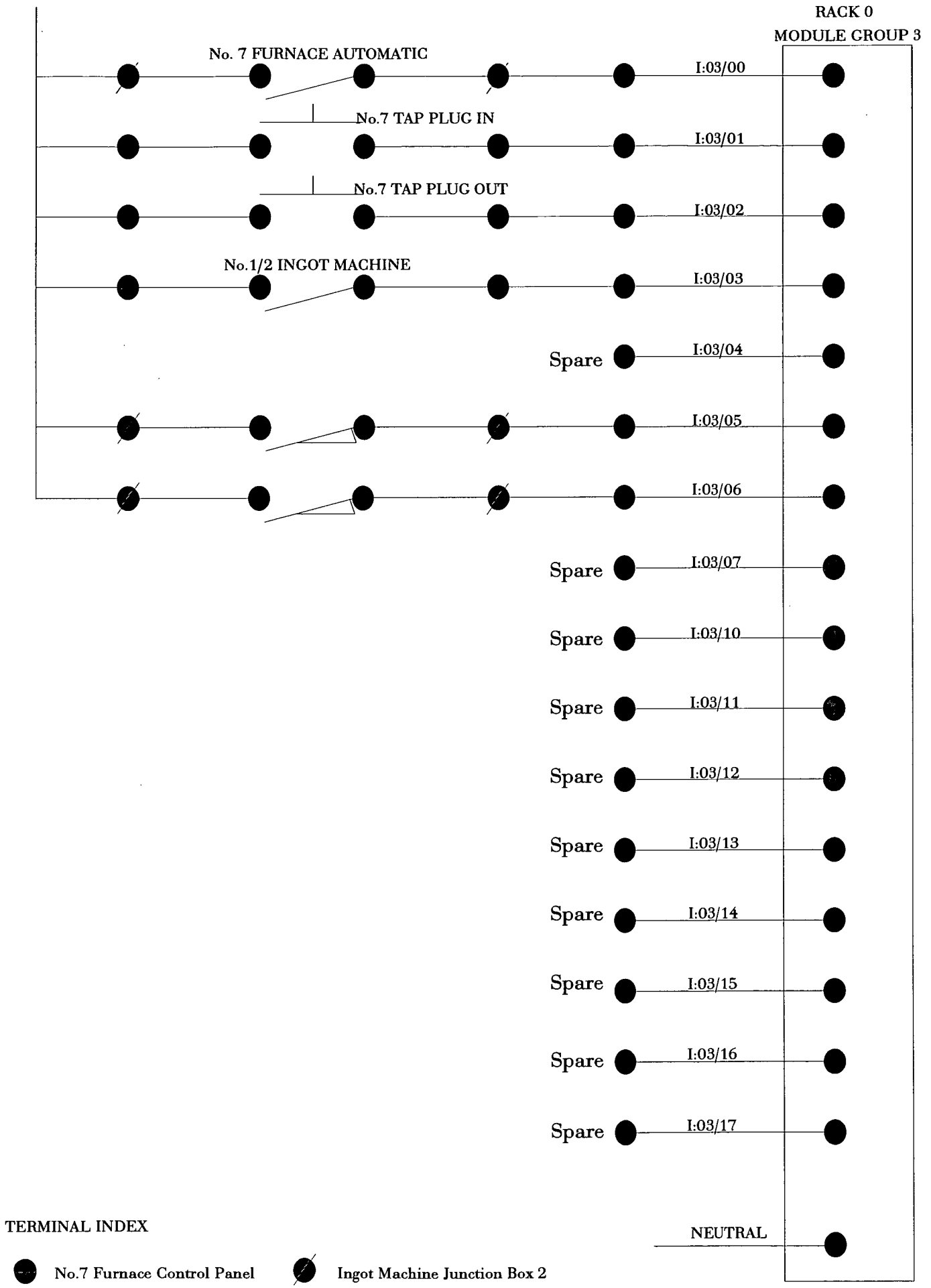
INGOT HEIGHT CONTROL SYSTEM



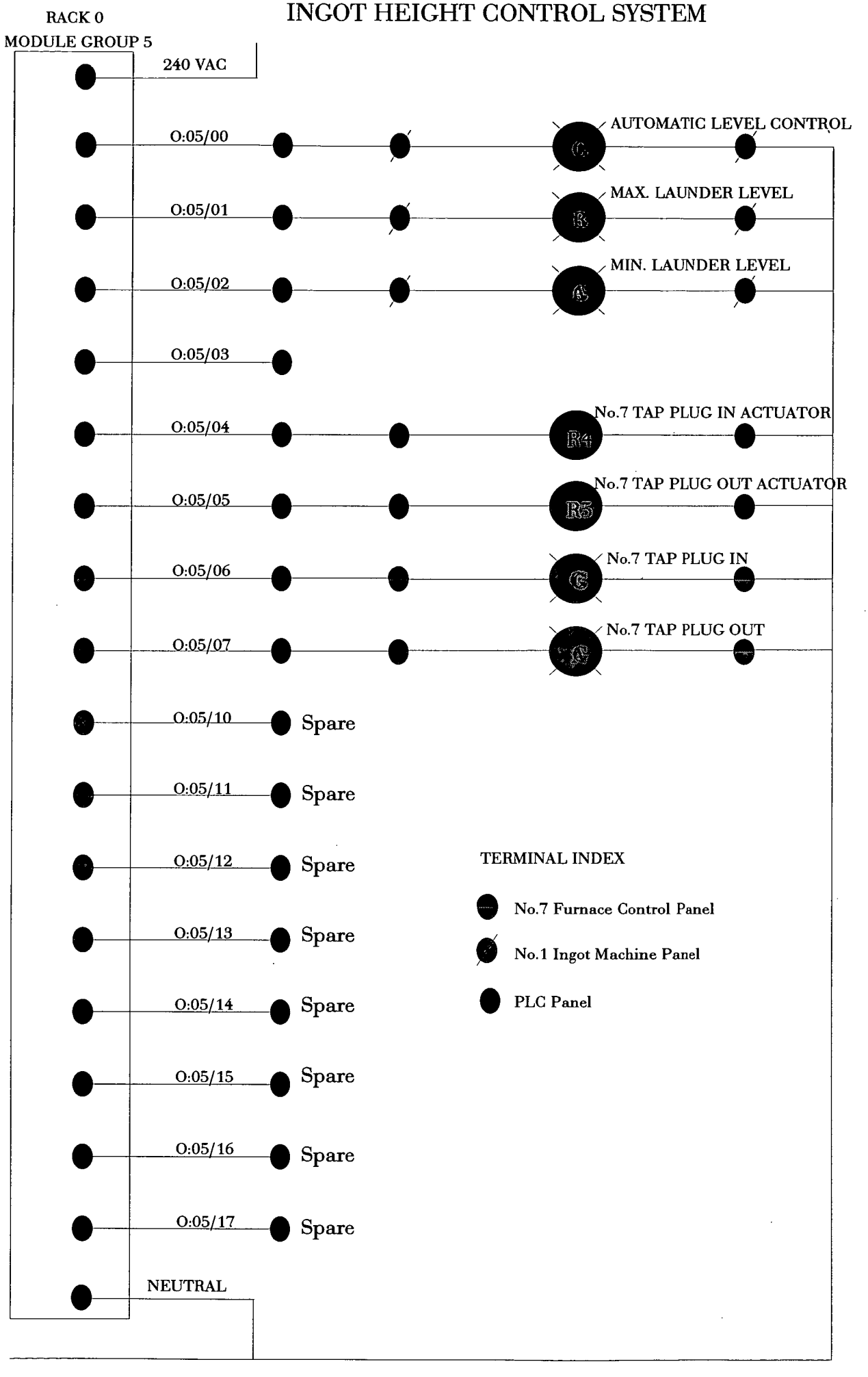
TERMINAL INDEX

- No.2 Ingot Machine Panel
- No.1 Ingot Machine Panel
- Junction Box 1
- Metal Flow Control Panel
- PLC Panel

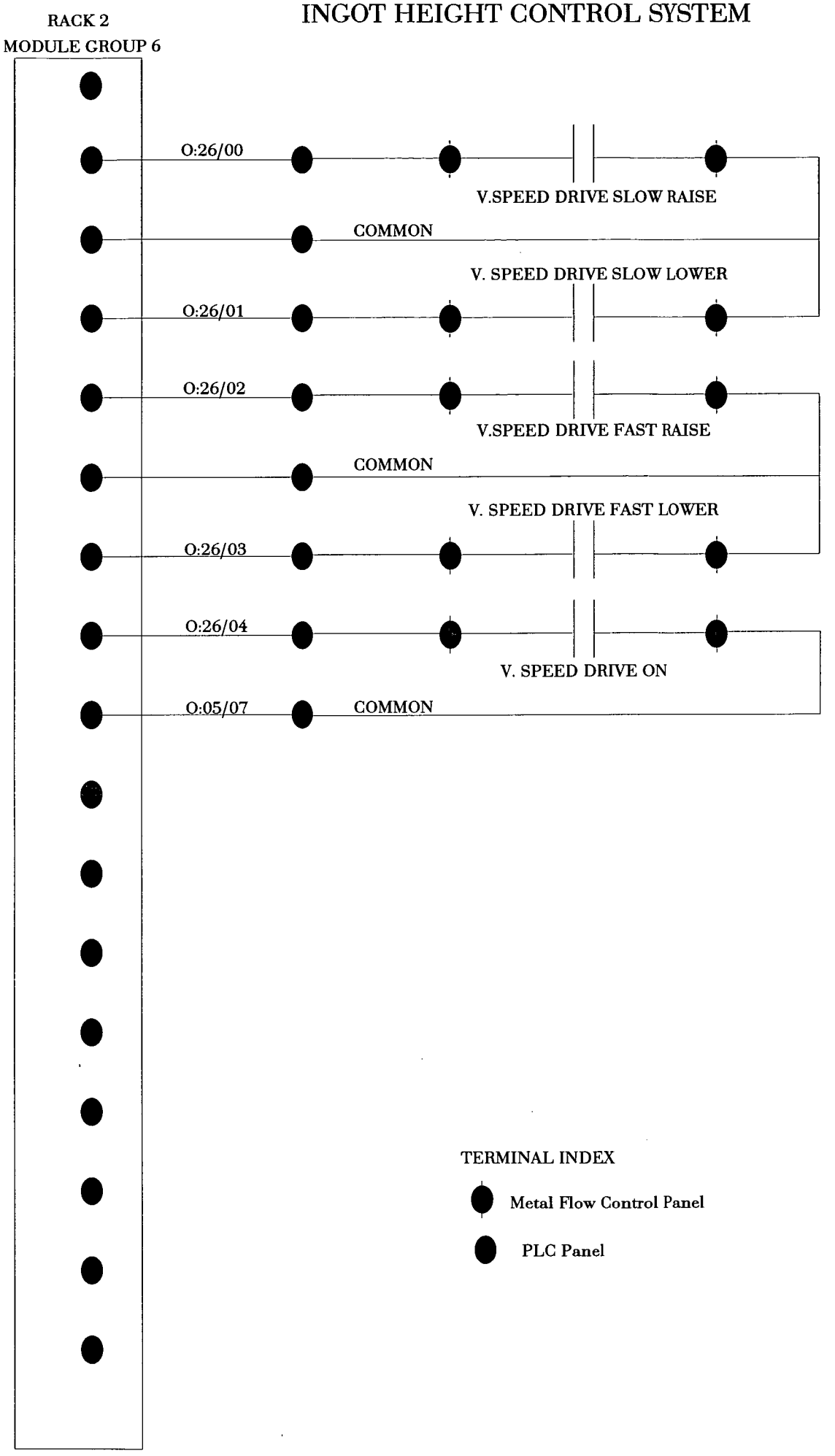
INGOT HEIGHT CONTROL SYSTEM



INGOT HEIGHT CONTROL SYSTEM



INGOT HEIGHT CONTROL SYSTEM



INGOT HEIGHT CONTROL

PLC/Citect Address', Descriptors & Values

N7:400	Ingot Height Setpoint	175
N7:401	Ingot Height High Side Deadband Range	45
N7:402	Ingot Height High Side Deadband Value	130
N7:403	Long/Short Pulse Discrimination (High Side) Range	30
N7:404	Long/Short Pulse High Side Value	100
N7:405	Ingot Height Lowside Deadband Range	-45
N7:406	Ingot Height Lowside Deadband Value	220
N7:407	Long/Short Pulse Discrimination (Low Side) Range	-30
N7:408	Long/Short Pulse Low Side Value	250
N7:410	Raise Weir Short Pulse Time	12
N7:411	Raise Weir Long Pulse Time	14
N7:412	Lower Weir Short Pulse Time	12
N7:413	Lower Weir Long Pulse Time	14

T4:35	Increase Ingot Height OFF Delay Control	55
T4:36	Raise Weir Pulse Timer	Variable
T4:37	Decrease Ingot Height OFF Delay Control	55
T4:38	Lower Weir Pulse Timer	Variable

CITECT ADDRESS'

Ingot Height **N20:01** **(PLC VALUE : Variable 0-700)**

Raw Zero :0 Raw Full Scale :700

Engineering Zero :65 Engineering Full Scale:100mm

Ingot Setpoint **N20:02** **(PLC VALUE : 525)**

Raw Zero :0 Raw Full Scale :700

Engineering Zero :65 Engineering Full Scale:100mm

Ingot UCL **N20:03** **(PLC VALUE : 570)**

Raw Zero :0 Raw Full Scale :700

Engineering Zero :65 Engineering Full Scale:100mm

Ingot LCL **N20:04** **(PLC VALUE : 480)**

Raw Zero :0 Raw Full Scale :700

Engineering Zero :65 Engineering Full Scale:100m

Launder Level Setpoint **N20:10** **(PLC VALUE : 500)**

Raw Zero :0 Raw Full Scale :1000

Engineering Zero :0 Engineering Full Scale:100m

Launder Level Height PV N20:11 **(PLC VALUE : Variable 0-1000)**

Raw Zero :0 Raw Full Scale :1000

Engineering Zero :65 Engineering Full Scale:100m

Furnace Proportional Valve 20:12 **(PLC VALUE : Variable 0-1000)**

Raw Zero :0 Raw Full Scale :1000

Engineering Zero :65 Engineering Full Scale:100%

CITECT TREND TAGS

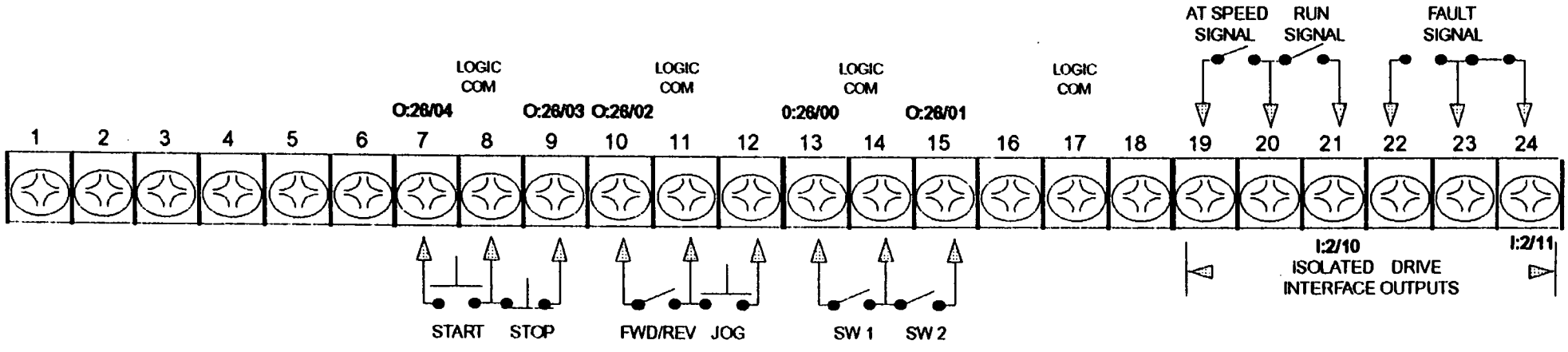
Trend Tag	Description
INGOT_HEIGHT	Trend of the average of the last 3 ingots
WEIR_OUTPUT	Not currently used
INGOT_LCL	Lower Control Limit for Ingot HeightControl
INGOT_UCL	Upper Control Limit for Ingot Height Control
INGOT_SETPOINT	Setpoint for Desired Ingot Height
LEV_SP	Launder Level Control - Launder Height SP
LEV_PV	Launder Level Control - Launder Sensor PV
LEV_OP	Launder Level Control - O/P Sent to Furnace

CITECT SCREEN FILES

File Name	Description
INGOTS	Ingot Height Trending Screen (Large Display)
LAUNDER	Launder Level/Ingot Height Trending Screen
STARTUP	Startup Page (Use when system is initialised)

DIRECTORY LISTING OF FILES

INGOTTREN.BMP	Ingot Height Trending Screen
LAUNDER.BMP	Launder Level/Ingot Height Trending Screen
STARTUP.BMP	Startup Page



WEIR VARIABLE SPEED DRIVE TERMINAL BLOCK CONNECTIONS

SET UP MODES

MODE DESCRIPTION	SETTING
1 Acceleration Time (secs)	1
2 Acceleration Time Multiplier	1
3 Deceleration Time (secs)	0.5
4 Deceleration Time Multiplier	1
5 Boost Level	A
6 Maximum Freq. & V/Hz	100
7 DC Brake Time (secs)	0.2
8 DC Brake Level (%)	7
9 Restart Mode	1
10 Frequency Control (Local/Extternal)	1
11 External Frequency Signal Type	1
12 Start/Stop: Forward/Reverse (Local/External)	1
13 Local Reverse Lockout	0
14 Stop Mode (Coast/Ramp)	0
15 Acceleration Stall Prevention	1
16 Deceleration Stall Prevention	1
17 Minimum Frequency	0.5
18 Maximum Frequency	100
19 Jog Frequency	10
20 2nd Preset Frequency	15
21 3rd Preset Frequency	70
22 4th Preset Frequency	40
23 1st Skip Frequency	0
24 2nd Skip Frequency	0
25 3rd Skip Frequency	0
26 Skip Frequency Range	0
27 Select Preset Frequencies	0
28 2nd Acceleration Time Multiplier	1
29 2nd Deceleration Time Multiplier	1
30 Last Fault Information	-
31 Current Limit Function	4

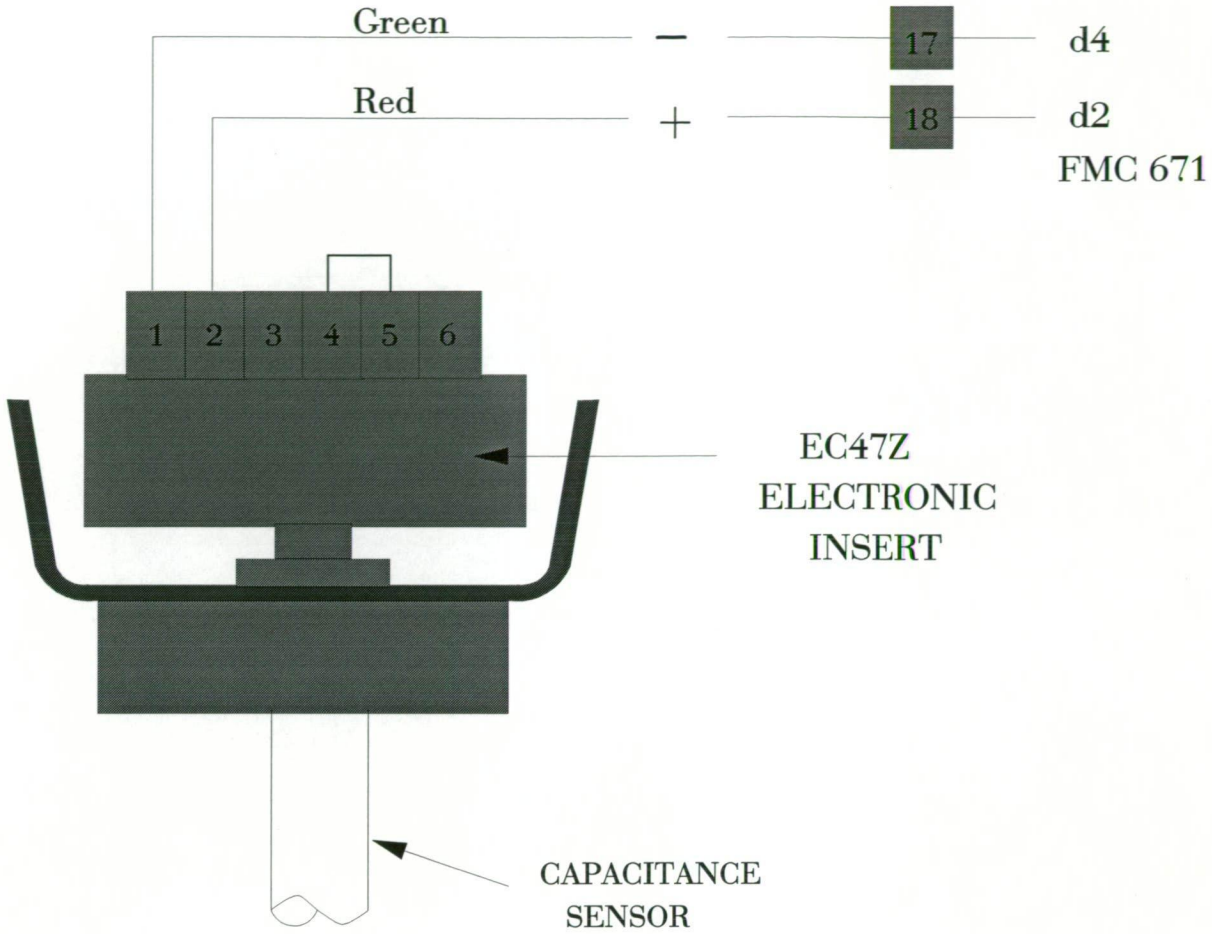
OPERATION MODE DISPLAY

MODE	START/STOP FORWARD/REVERSE	FRQUENCY CONTROL
LL	LOCAL (CONTROL PANEL)	LOCAL (CONTROL PANEL)
LE	LOCAL (CONTROL PANEL)	EXTERNAL (CONTROL TB)
EL	EXTERNAL (CONTROL TB)	LOCAL (CONTROL PANEL)
EE	EXTERNAL (CONTROL TB)	EXTERNAL (CONTROL TB)

FAULT DISPLAY

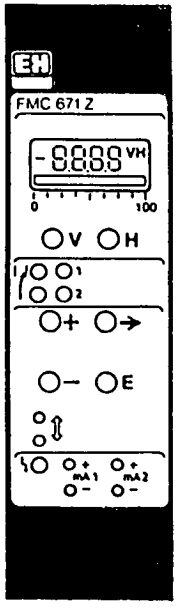
OC	OVER CURRENT
OL	OVER LOAD
OU	OVER VOLTAGE
LU	LOW VOLTAGE
OH	OVER TEMPERATURE
AU	AUX. INTERLOCK
OP	OPERATION ERROR

WEIR VARIABLE SPEED MODE DISPLAYS



Launder Level Sensor - Connections

FMC 671 Z / FMC 676 Z



V,H = Position within matrix

→ = Cursor position in display

\+ = increase

− = decrease

E = Confirm input

↕ = Connection with COMMULOG

Input

Display

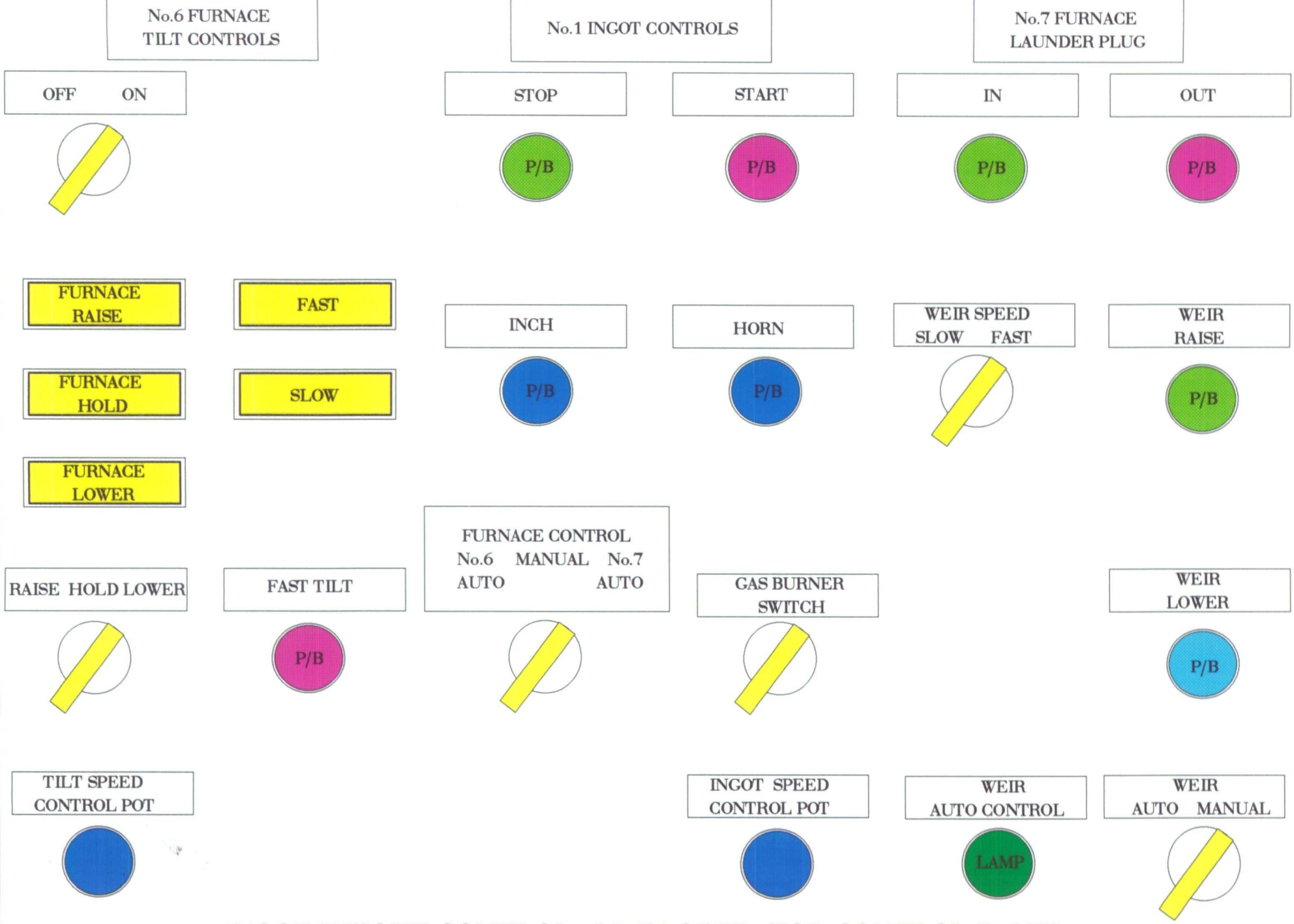
E_1, E_2 = Input 1, 2

A_1 = Anal. Output

	H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
V0 Calibration Channel 1	Display Actual Measured Value	Empty Calibration	Full Calibration	Select Current 0 = 0...20 mA 1 = 4...20 mA	Output Damping (s)	Value for 4 mA or 0 mA	Value for 20 mA	Safety Alarm 0 = −10% 1 = 110% 2 = hold	Actual Measuring Frequency	Measured Value before linearization
V1 Limit Value Channel 1	Relay 1 Switching Point	Relay 1 Fail-safe Mode 0 = min. 1 = max.	Relay 1 Hysteresis	Relay 1 at Alarm 0=de-energis. 1 = as A_1	Relay 1 1 = f(A_1) 2 = f(E_2)	Relay 2 Switching Point	Relay 2 Fail−safe mode 0 = min. 1 = max.	Relay 2 Hysteresis	Relay 2 at Alarm 0=de-energis. 1 = as A_1	Relay 2 1 = f(A_1) 2 = f(E_2)
V2 Linearization Channel 1	0 = linear 1=horiz. cyl. 2=factory-set 3=manual 4=clear 3	Level Input Mode 0=manual 1=automatic	Tabel No. 1...30	Input Volume	Input Level	Next Table No.	Number of Factory-set Characteristic	Diameter for Horizontal Cylinder	Volume for Horizontal Cylinder	
V3 Extended Calibration Channel 1	Calibration Mode 0=level 1=volume	Offset	Sensitivity		Zero Offset Value	Offset Electronic Insert	Sensitivity Electronic Insert		D/A Calibration 0 mA	D/A Calibration 20 mA
V8 Operating Mode	0=FMC/FTC 1=FMC only 2=FTC only see V8H1	from V8H0 5=Cal. Corr 6=Sim./Cal. 1 7=Sim. FTC	Switch Delay Time (s)	Sensor position for Cal. Corr.	Type of Sensor 0=DL 17 Z 1=EC 17	Calibration EC 17 Z 0=free 1=covered	Calibration EC 17 Z Switching Point 0.1...100 Hz	Factor for Calibration Correction	Actual Measuring Frequency FTC	Security Locking <670 or >679
V9 Service and Simulation	Display Actual Diagnostic Code	Display Previous Diagnostic Code		Instrument and Software No.	Address E+H Bus	Set to Default Values 670...679	Simulation Frequency	Simulation Level	Simulation Volume	Simulation Current

deutsche Ausführung siehe Rückseite

918296-0003 B

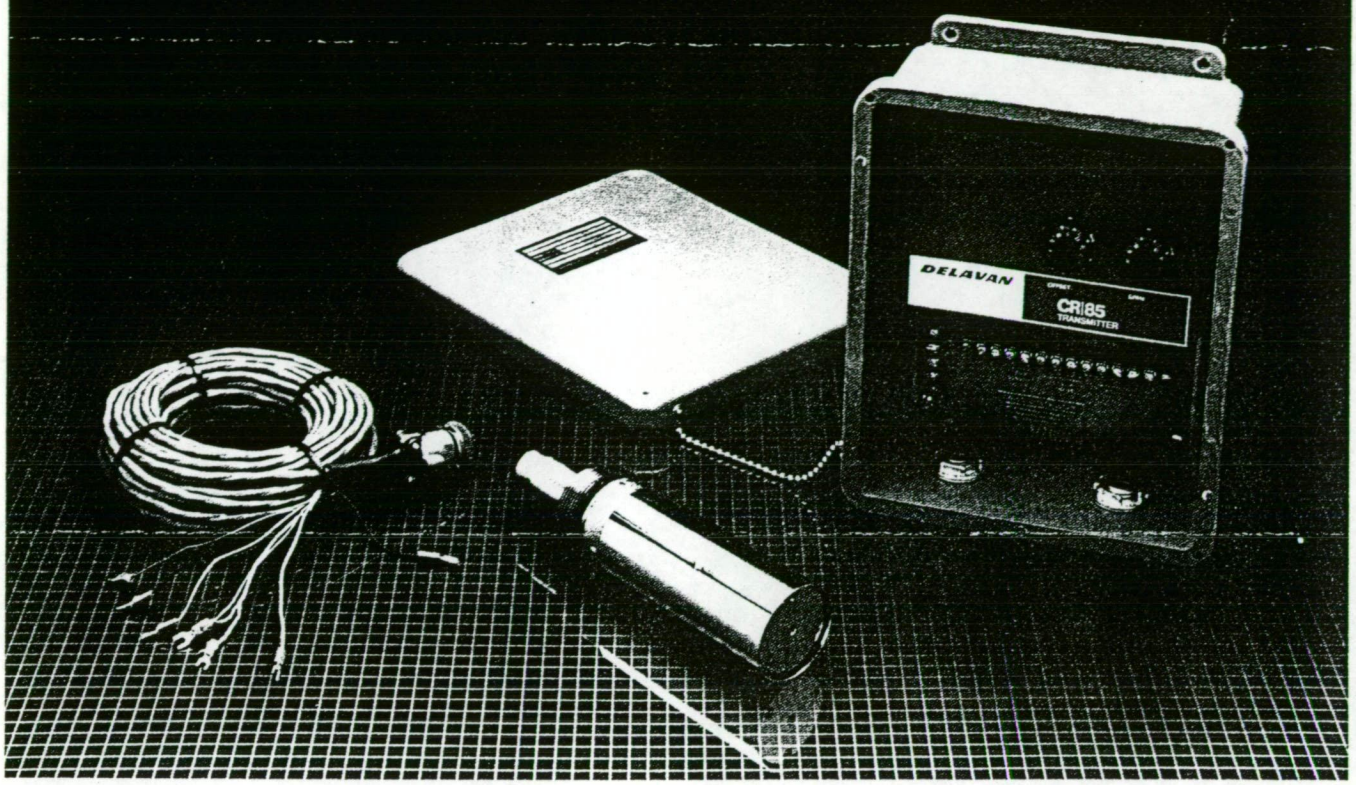


INGOT HEIGHT CONTROL - MAIN OPERATOR CONTROL PANEL

DELAVAN
ELECTRONICS

DATA SHEET

HOT PROX/620 Level & Position



Function
Precision level measurement and control of hot liquids

Typical Uses

Electro magnetic casting
Precision indication and control of molten metal for electro magnetic casting and direct chill processes.

Trough level
Trough level sensing for control of tilting furnaces.

Features

Non-contact
The sensor does not touch the surface of the process material. No moving parts to wear or stick.

Precision
The HOT PROX/620 will measure level variables with long term accuracy of ±.002 inches or better.

Response time
The minimum response time is less than 1 millisecond.

Electronically guarded
An electronic guarded sensing element prevents interaction to other objects or surfaces.

Non-magnetic material
The sensor is specifically designed to operate near electromagnetic force fields.

Air-cooled/high temperature
Provisions are made so the user can air cool the sensor when used in high temperature applications, and monitor the internal sensor temperature.

Principle of Operation
A typical HOT PROX/620 system consists of a sensor mounted near the process variable connected to the amplifier transmitter with special high temperature cable. The sensor is designed to measure changes of capacitance to ground as they occur. The process material would act as the grounded plate similar to a parallel plate capacitor. Any change in level would appear to the sensor as a change in distance between the plates.

K = Constant A = Plate area $C = \frac{K \varepsilon A}{d}$
ε = Dielectric constant of material between plates
d = Distancebetween plates

The sensor utilizes a mechanically stable sensing plate that is parallel to the surface of the process being measured. Any variation of the distance between the sensor plate and the subject is detected. The resultant change of capacitance will vary the frequency of a variable oscillator located in the preamplifier on the rear of the sensor.

This signal is transmitted to the amplifier and the frequency is converted to a voltage. After processing, the output is available for control purposes. Within the recommended ranges the output voltage or current will be linear and proportional to the distance changes. The sensor measuring plate is guarded to prevent false signals from other objects or surfaces not in the desired sensing area.

RAYMOND CONTROL SYSTEMS
A BRUNSWICK COMPANY

TYPE AR
FIELD INSTALLATION INSTRUCTIONS
ELECTRIPOWR ACTUATOR

SAFETY FIRST

In the maintenance and operation of mechanical equipment, **SAFETY** is the basic factor which must be considered at all times. Through the use of the proper clothes, tools and methods of handling, serious accidents causing injury to you or your fellow worker can be prevented.

Throughout this manual are listed a number of safety precautions. Study them carefully and follow them; also insist upon those working for you do the same. Remember, an accident is usually caused by someone's carelessness, neglect or oversight.

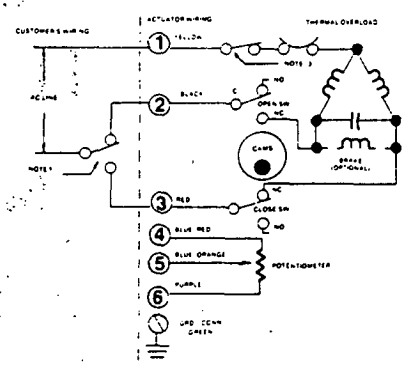
CAUTION To prevent ignition of hazardous atmospheres, do not remove actuator cover while circuits are live. **CAUTION**

INSTALLATION

1. Operate valve manually before installing actuator and place into open position.
2. If valve is equipped with mechanical position stops they should be removed, but care should be taken not to damage or remove necessary parts from the valve.
3. When actuator is supplied separately from valve, actuator will be shipped in valve open position and care should be taken to maintain proper alignment between the actuator and valve shafts. If actuator and valve shafts are not in correct alignment repeat operation number one (1) with correction as required.
4. Mount the actuator to the valve. The actuator is usually mounted parallel to the run of the pipe. Tighten all bolts and nuts evenly, taking care to center the actuator on the valve stem. It is often a good idea to cycle the actuator while the mounting bolts are somewhat loose. This will allow the unit to center itself.
5. Loosen socket set screw and remove the manual declutching knob (Models MAR-10, -25, -50 & -90 only).
6. Remove the hex head bolts located about the flange of the unit.
7. Wire per diagram, or if actuator is of special design, wiring diagram is included with unit. Wiring diagram is drawn with valve in open position. Use #18AWG stranded wire or better, for field hook-up.
8. Run unit from one extreme to the other several times.

STANDARD WIRING DIAGRAMS

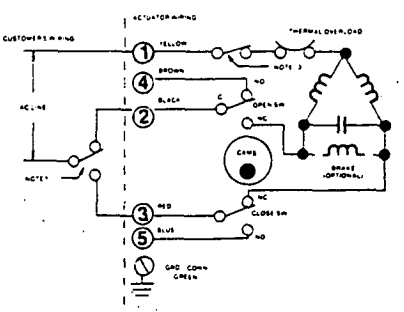
REVERSIBLE WITH POTENTIOMETER



NOTES:
1. SWITCH SHOWN FOR ILLUSTRATION ONLY.
2. ACTUATOR IS SHOWN IN OPEN POSITION.
3. MANUAL LOCKOUT SWITCH IS STANDARD ON UNITS MAR-100/MAR-4000 AND DOESN'T FUNCTION OFF CAM SHOWN.
4. POWER TO TERMINAL "3" OPERATES UNIT INTO CLOSE POSITION (C.W. STD.).
5. POWER TO TERMINAL "2" OPERATES UNIT INTO OPEN POSITION (C.C.W. STD.).

WD 101-05

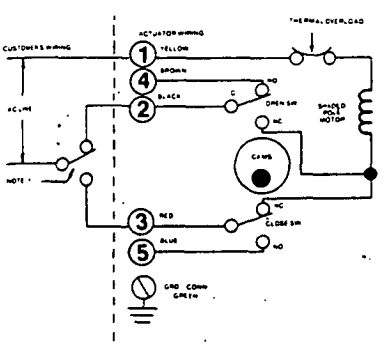
STANDARD REVERSIBLE



NOTES:
1. SWITCH SHOWN FOR ILLUSTRATION ONLY.
2. ACTUATOR IS SHOWN IN OPEN POSITION.
3. MANUAL LOCKOUT SWITCH IS STANDARD ON UNITS MAR-100/MAR-4000 AND DOESN'T FUNCTION OFF CAM SHOWN.
4. POWER TO TERMINAL "3" OPERATES UNIT INTO CLOSE POSITION (C.W. STD.).
5. POWER TO TERMINAL "2" OPERATES UNIT INTO OPEN POSITION (C.C.W. STD.).
6. WIRING FROM THE NORMALLY OPEN CONTACTS OF THE SWITCHES IS PROVIDED FOR LIGHT INDICATION.

WD 101-01

STANDARD UNIDIRECTIONAL*



NOTES:
1. SWITCH SHOWN FOR ILLUSTRATION ONLY.
2. ACTUATOR IS SHOWN IN OPEN POSITION.
3. POWER TO TERMINAL "3" OPERATES UNIT INTO CLOSE POSITION (90° C.W. STD.).
4. POWER TO TERMINAL "2" OPERATES UNIT INTO OPEN POSITION (90° C.W. STD.).
5. WIRING FROM THE NORMALLY OPEN CONTACTS OF THE SWITCHES IS PROVIDED FOR LIGHT INDICATION.

*Except MA-4 which is not available with terminal strip. Light wiring is optional.

WD 100-03

Metaval
Gatwick Road, Bayswater, 3153, Australia.
O. Box 1093, Croydon, 3136.
elephone: 03 761 4000. Fax: 61 3 761 4006.

FORM NO. 700A-5/84

CAUTION

To prevent ignition of hazardous atmospheres, do not remove actuator cover while circuits are live.

CAUTION

INSTALLATION CON'T.

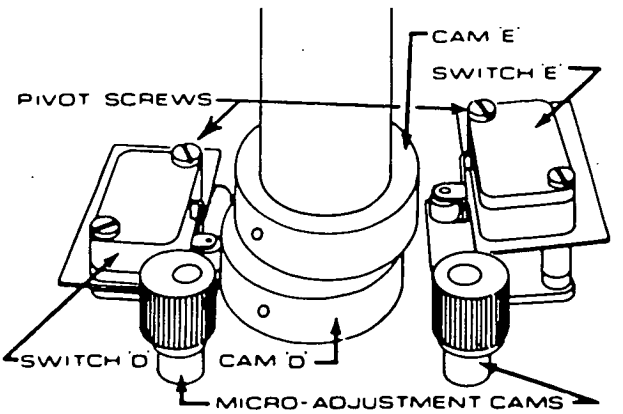
9. Cam adjustments (if required), as follows:

To set open travel by adjusting cams:

(a) Loosen clamping screw on cam "D" to give the cam a finger tight grip on shaft, rotate cam clockwise away from switch.
(b) Manually operate valve to the proper "open" position.
(c) Rotate cam "D" counter-clockwise against switch roller until switch just "breaks". You should hear a light clicking.
(d) Tighten clamping screw. If travel is not correct, repeat steps (a), (b) and (c), or use the micro-adjustment cam.

To set close travel by adjusting cams:

(a) Loosen clamping screw on cam "E" to give the cam a finger tight grip on shaft, rotate cam counter-clockwise away from the switch.
(b) Manually operate valve to the proper "close" position.
(c) Rotate cam "E" clockwise against switch roller until switch just "breaks". You should hear a light clicking.
(d) Tighten clamping screw. If travel is not correct, repeat steps (a), (b) and (c), or use the micro-adjustment cam.



NOTE: In the event that the above procedure does not give the necessary travel control, the micro-adjustment cam has to be repositioned as follows:

To set open travel by adjusting switch plate:

(a) Loosen pivot and micro-adjustment screws on switch "D".
(b) In the event of actuator under travel, rotate micro-adjustment cam to swing switch outward from the cam post.
(c) In the event of actuator over-travel, swing switch into cam post.
(d) Tighten pivot and micro-adjustment screws on switch "E".

To set close travel by adjusting switch plate:

(a) Loosen pivot and micro-adjustment screws on switch "E".
(b) In the event of actuator under-travel, rotate micro-adjustment cam to swing switch outward from cam post.
(c) In the event of actuator over-travel, swing switch into cam post.
(d) Tighten pivot and micro-adjustment screws on switch "E".

10. Replace cover and tighten all flange bolts.

11. Replace manual declutching knob and tighten socket set screw (Models MAR-10, -25, -50 & -90 only).

12. Unit is now ready for automatic operation.

CAUTION

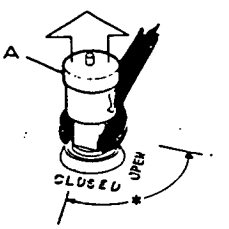
Potentiometer: (optional) During initial field installation of actuators incorporating our standard potentiometer range, care must be taken to avoid overstepping the pre-set travel limits. This is to avoid damage to the potentiometer. R.C.S. has a very unique mounting bracket for holding the pot. such that even when the pre-set position is overshot, the pot. will not be damaged. However, good field installation practice would and should dictate the avoidance of this wherever possible to avoid any possible damage to the pot., also possibility of overtwisting the pot. wire leads. Potentiometer specs - as per customer requirements.

CAUTION

TO MANUALLY OPERATE

Models MA-4, -8, MAR-8, -9, -12, -24, -49 & -89:
Manual operation is accomplished by use of an open end wrench on the hex stock coupling adapter.
Direction of rotation and or position can be checked by indicator located on output shaft.
Avoid turning beyond normal open/close travel.

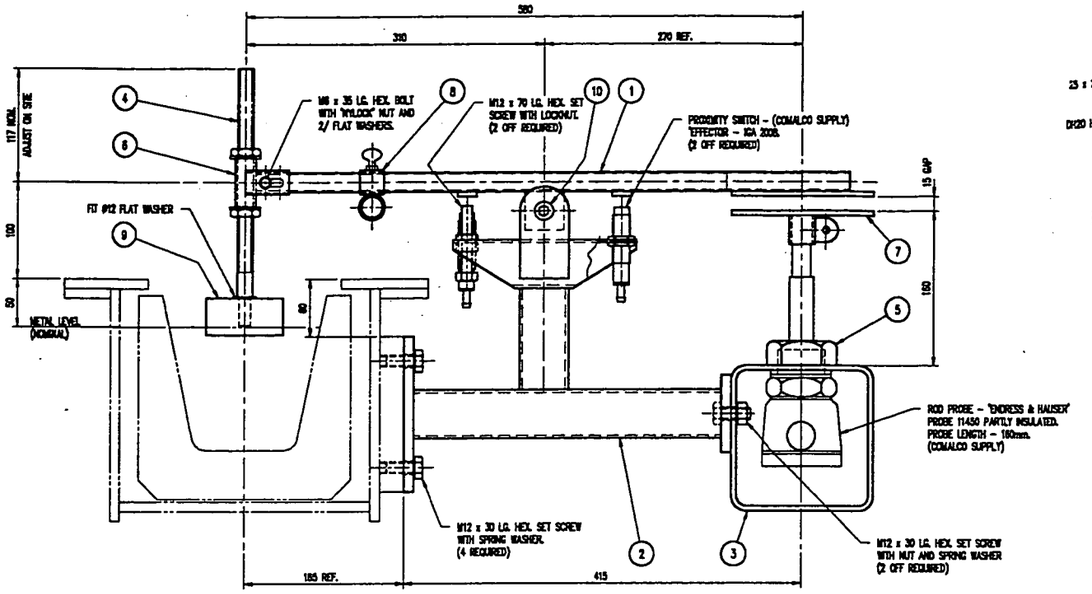
Models MAR-10, -13, -25, -50 & -90:
Pull the black "declutching knob" (A) all the way up and hold. Gently rock shaft back and forth with wrench to disengage, and rotate to desired position as indicated by the arrows.
Actuator will automatically re-engage when "knob" is released and electrical power is applied.
Avoid turning beyond normal open/close travel.



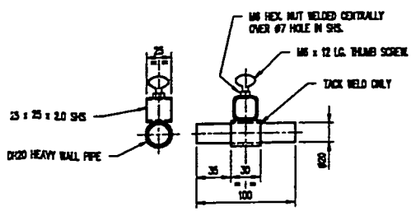
Models MAR-100, -120, -160, -250, -800, -1600 & -4000:
Depress and rotate handwheel slowly until lower detent is felt to engage.
Turn handwheel in desired direction (note markings on wheel and check position by indicator located on output shaft).
Avoid turning beyond normal open/close travel.
When handwheel is returned to raised position, normal operation is restored (see manual cut-out switch).

Manual Cut-Off Switch:
When handwheel is depressed for manual operation, integral cut-off switch prevents injury due to unexpected restoration of power and is automatically reset when handwheel is returned to raised position.

DO NOT SCALE – IF IN DOUBT – ASK

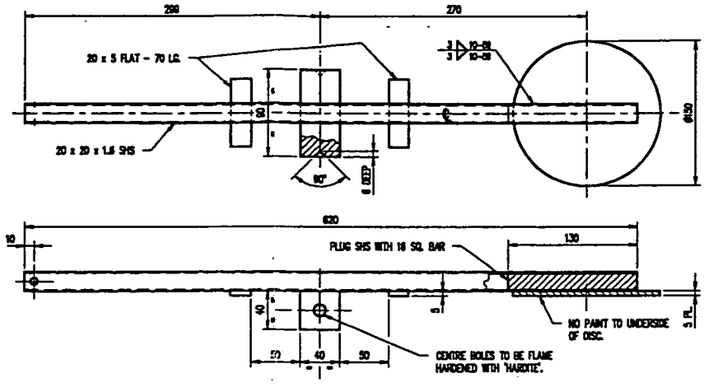


LEVEL SENSOR ARRANGEMENT.



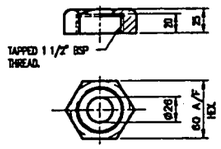
COUNTERWEIGHT ASSY – ITEM (8)

1 OFF REQUIRED
MATERIAL – MILD STEEL



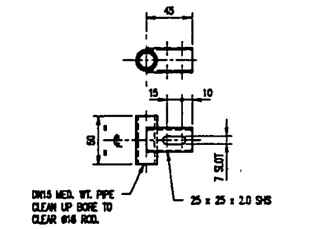
LEVER ARM – ITEM (1)

1 OFF REQUIRED
MATERIAL – MILD STEEL



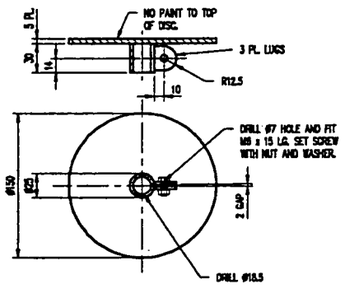
BACK NUT – ITEM (5)

1 OFF REQUIRED
MATERIAL – MILD STEEL
PROVIDE WITH O.D.45 x I.D.25 x 3 THK RUBBER WASHER.



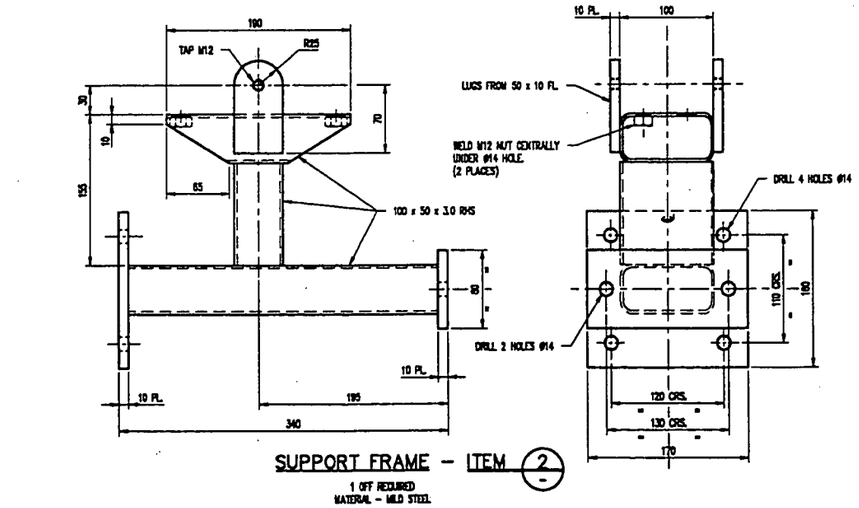
LEVER HEAD – ITEM (6)

1 OFF REQUIRED
MATERIAL – MILD STEEL



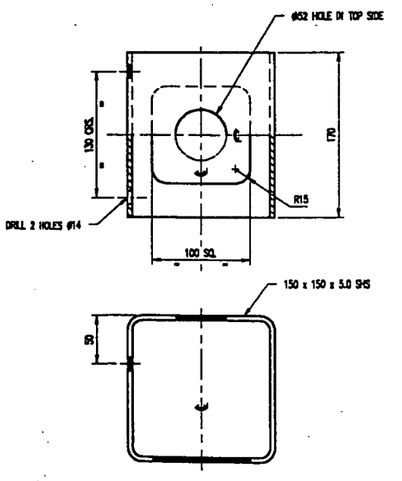
CAPACITANCE PLATE – ITEM (7)

1 OFF REQUIRED
MATERIAL – MILD STEEL



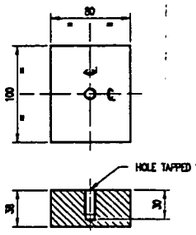
SUPPORT FRAME – ITEM (2)

1 OFF REQUIRED
MATERIAL – MILD STEEL



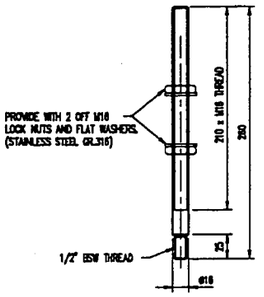
PROBE MOUNTING BRACKET – ITEM (3)

1 OFF REQUIRED
MATERIAL – MILD STEEL



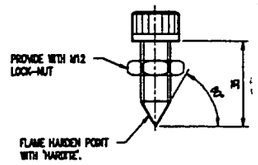
FLOAT – ITEM (9)

1 OFF REQUIRED
MATERIAL – 'PYROTEC' N14
(MAKE FROM STOCK MAT'L No.825900:)
(COMALCO SUPPLY)



FLOAT ROD – ITEM (4)

1 OFF REQUIRED
MATERIAL – STAINLESS STEEL GR. 316.



PIVOT SCREW – ITEM (10) SCALE – 1:1

2 OFF REQUIRED
(M/C FROM M12 x 35 LG. SOCKET HEAD CAP SCREW.)

GENERAL NOTES:–

1. ALL WELDING SHALL CONFORM TO AS1554
   - FILLET WELDS TO BE 3mm (MIN.) UNLESS NOTED OTHERWISE.
   - BUTT WELDS TO BE FULL PENETRATION.
2. REMOVE ALL BURRS AND SHARP EDGES.
3. SURFACE PREPARATION AND PAINTING TO BE IN ACCORDANCE WITH COMALCO STANDARD SPECIFICATION 'P1'
   - COATING SYSTEM 'D' (TOP COAT Y15 SUNFLOWER) FOR ITEMS 2, 3, 5 & 7.
   - COATING SYSTEM 'F' FOR ITEMS 1, 8 & 9.

REVISIONS

EXCEPT WHERE OTHERWISE STATED
DIMENSIONS IN MILLIMETRES
TOLERANCES
MACHINED ± 0.5
FABRICATED ± 2
ANGULAR ± 1°
PROJECTION 3RD ANGLE

REFERENCE DRAWING NOS.	
FEED LAUNDER LAYOUT	17765
LEVEL CONTROL WEIR ARRGT	17767
FEED LAUNDER DETAILS	17768
SKIMMER WEIR ARRGT & DETS.	17770

DISC No. 107

COMALCO ALUMINIUM (BELL BAY) LIMITED, TASMANIA

PROCESS	DRAWN	Jolly N.L.	DATE 20-10-95
MAINTENANCE	CHECKED		
SAFETY	PASSED		
ENG. DEPT.	ENGG. CONS.		
	APPROVED		

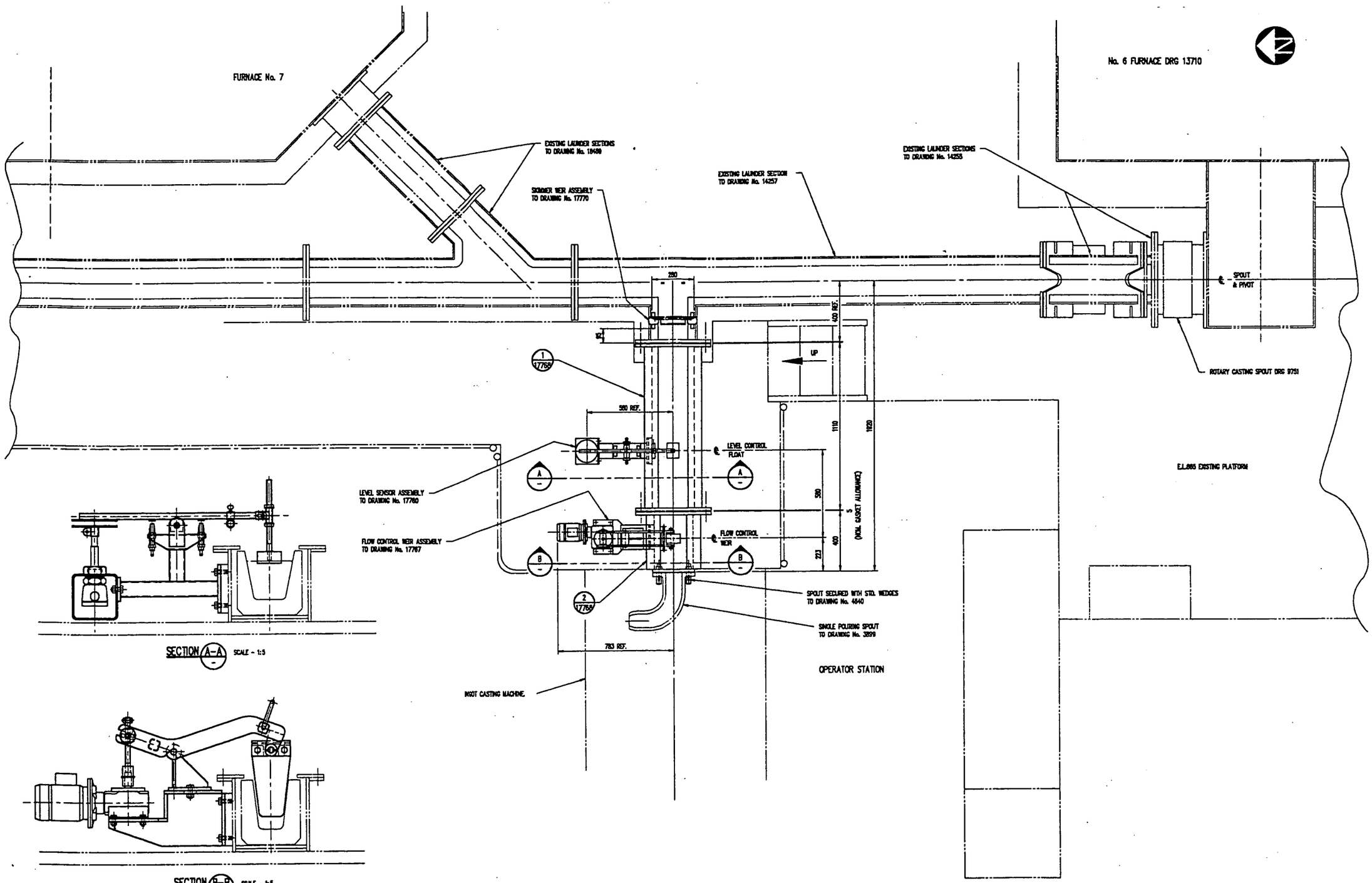
METAL PRODUCTS
INGOT CASTING
LAUNDER LEVEL SENSOR ARRANGEMENT AND DETAILS

SCALE 1: 2.5 & AS NOTED

DRG.NO 17760

REVISION

DO NOT SCALE – IF IN DOUBT – ASK



REVISIONS

EXCEPT WHERE OTHERWISE STATED
DIMENSIONS IN MILLIMETRES
TOLERANCES
MACHINED ± 0.5
FABRICATED ± 2
ANGULAR ± 1°
PROJECTION 3RD ANGLE

REFERENCE DRAWING NOS.		PROCESS		DRAWN	DATE
LEVEL SENSOR ARRANGEMENT & DETS.	17760			Jolly N.L.	14-12-98
FLOW CONTROL WEIR ARRANGEMENT & DETS.	17767	MAINTENANCE		CHECKED	
LAUNDER SECTION DETAILS	17768			PASSED	
SKIMMER WEIR ARRANGEMENT & DETS.	17770	SAFETY		FINAL CHK.	
				APPROVED	
DISC No. 107		ENG. SUPT.			

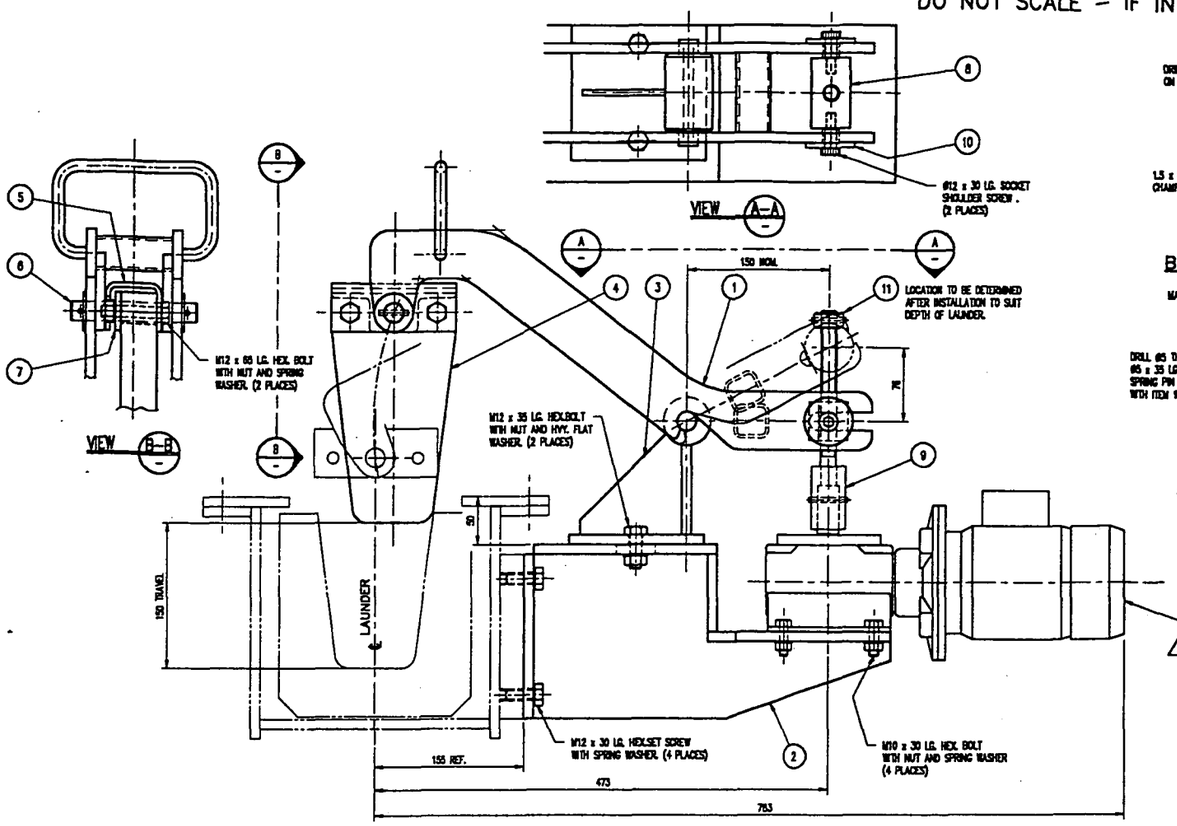
COMALCO ALUMINIUM (BELL BAY) LIMITED, TASMANIA

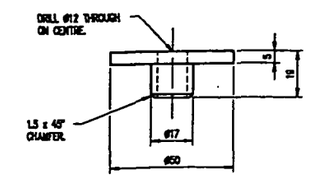
METAL PRODUCTS
INGOT CASTING
No.1 MACHINE FEED LAUNDER
LAYOUT

SCALE 1:10 & AS NOTED

DRG.NO 17766

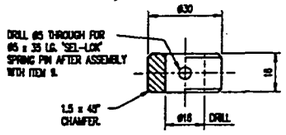
DO NOT SCALE – IF IN DOUBT – ASK





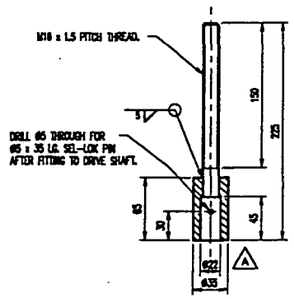
BUSH – ITEM 10 SCALE – 1:1

2 OFF REQUIRED
MATERIAL – STAINLESS STEEL



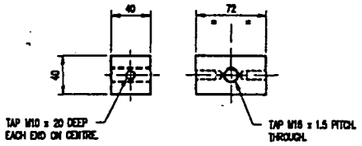
STOP COLLAR – ITEM 11 SCALE – 1:1

1 OFF REQUIRED
MATERIAL – STAINLESS STEEL



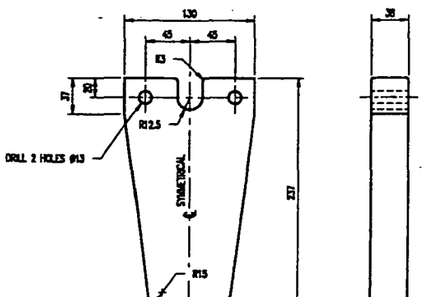
DRIVE SCREW – ITEM 9

1 OFF REQUIRED
MATERIAL – STAINLESS STEEL



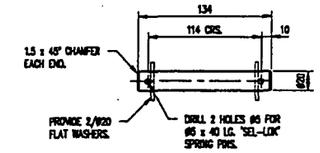
FOLLOWER – ITEM 8

1 OFF REQUIRED
MATERIAL – BRASS



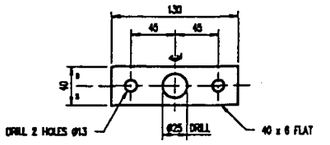
WEIR – ITEM 4 (COMALCO SUPPLY)

1 OFF REQUIRED
MATERIAL – 'PYROTEX' W17



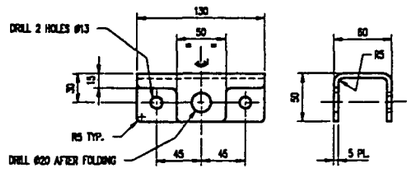
PIN – ITEM 6

1 OFF REQUIRED
MATERIAL – STAINLESS STEEL



BACKING PLATE – ITEM 7

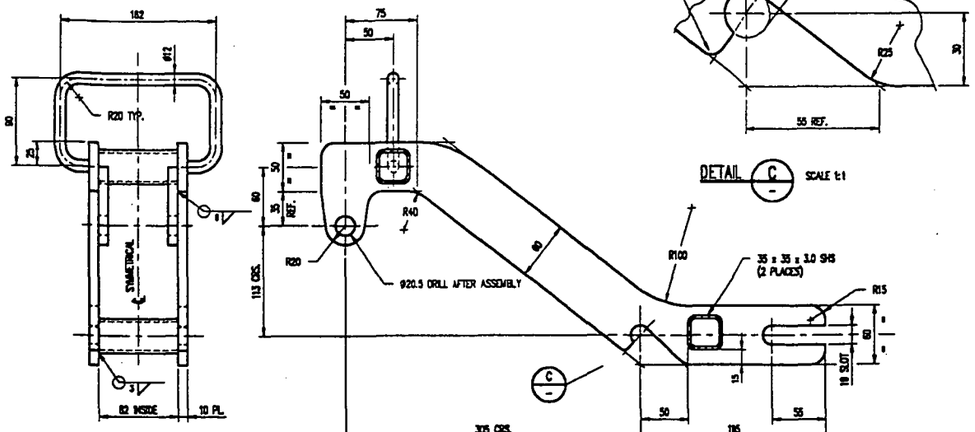
1 OFF REQUIRED
MATERIAL – MILD STEEL



WEIR SUPPORT – ITEM 5

1 OFF REQUIRED
MATERIAL – MILD STEEL

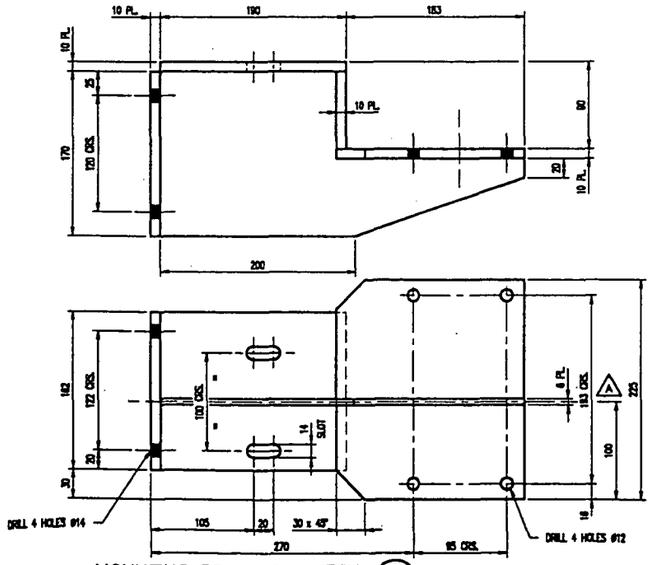
LEVEL CONTROL WEIR ARRANGEMENT



DETAIL C SCALE 1:1

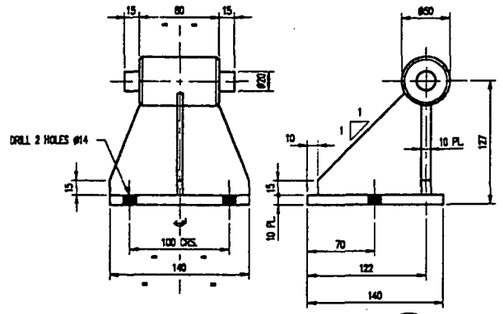
LEVER ARM – ITEM 1

1 OFF REQUIRED
MATERIAL – MILD STEEL



MOUNTING BRACKET – ITEM 2

1 OFF REQUIRED
MATERIAL – MILD STEEL



PIVOT BRACKET – ITEM 3

1 OFF REQUIRED
MATERIAL – MILD STEEL

GENERAL NOTES:–

1. ALL WELDING SHALL CONFORM TO AS1554
   - FILLET WELDS TO BE 6mm (MIN.) UNLESS NOTED OTHERWISE.
   - BUTT WELDS TO BE FULL PENETRATION.
2. REMOVE ALL BURRS AND SHARP EDGES.
3. SURFACE PREPARATION AND PAINTING TO BE IN ACCORDANCE WITH COMALCO STANDARD SPECIFICATION 'P1'
   - COATING SYSTEM 'D' (FINAL COAT COLOUR Y15 SUNFLOWER) FOR ITEMS 2 & 3 ONLY
   - COATING SYSTEM 'F' FOR ITEMS 1, 5 & 7.

(ALL OTHER ITEMS TO BE UNPAINTED)

REVISIONS

A GEAR UNIT CHANGED – ITEMS No.2 & 9 MODIFIED TO SUIT. JDL. 13-11-91

EXCEPT WHERE OTHERWISE STATED DIMENSIONS IN MILLIMETRES
TOLERANCES
MACHINED ± 0.5
FABRICATED ± 2
ANGULAR ± 1°
PROJECTION 3RD ANGLE

REFERENCE DRAWING NOS.	
LAUNDER LAYOUT	17765
LAUNDER LEVEL SENSOR ARRGT	17760
FEED LAUNDER DETAILS	17768
SKIMMER WEIR ARRGT & DETS.	17770

DISC No. 107

COMALCO ALUMINIUM (BELL BAY) LIMITED, TASMANIA

METAL PRODUCTS
INCOT CASTING
LAUNDER LEVEL CONTROL WEIR ARRANGEMENT AND DETAILS

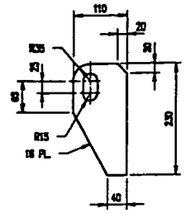
DESIGN	Jolly N.L.	09-01-91
CHECKED		
PASSED		
PROJ. ENG.		
APPROVED		

SCALE 1:2.5 & AS NOTED

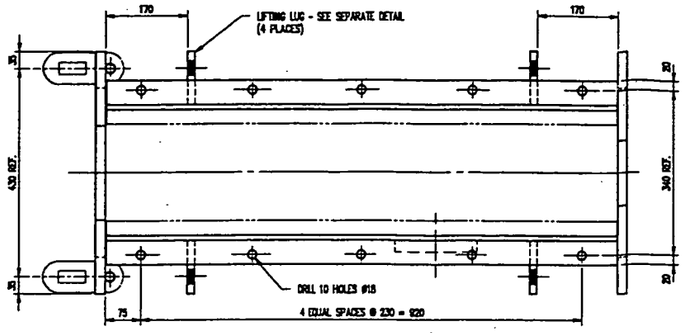
DRG.NO 17767

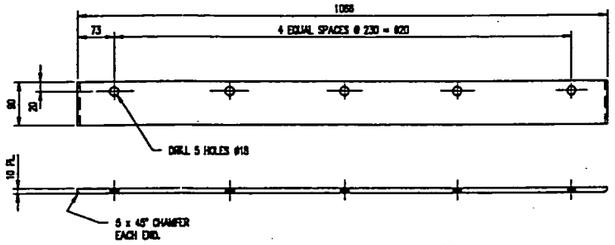
REVISION A

DO NOT SCALE – IF IN DOUBT – ASK

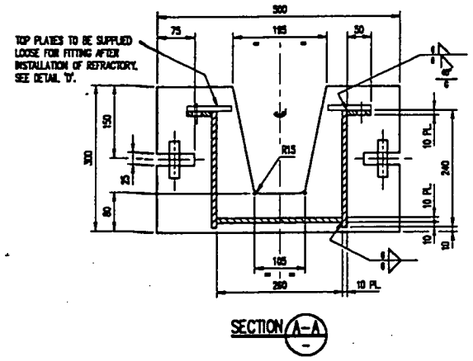


LIFTING LUG DETAIL

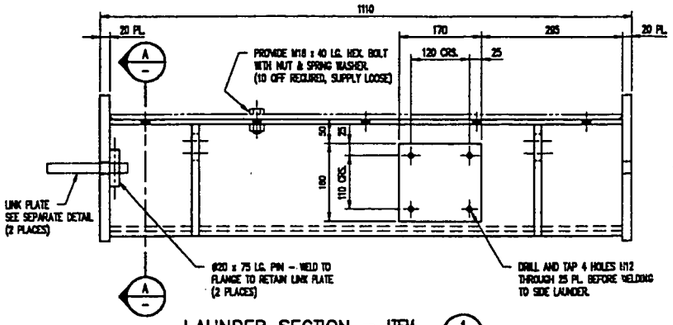




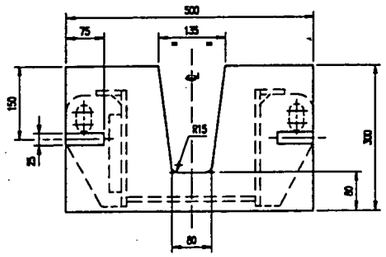
TOP PLATE – DETAIL D
2 OFF REQUIRED

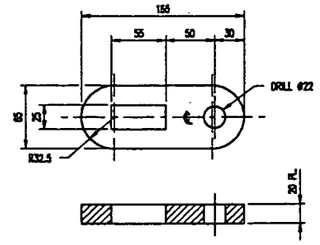


SECTION A-A

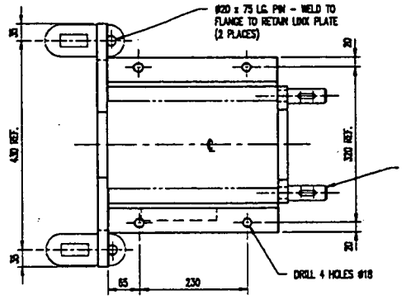


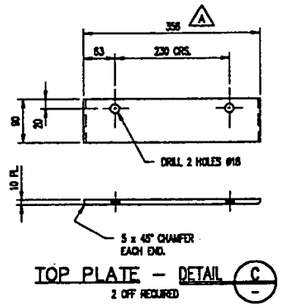
LAUNDER SECTION – ITEM 1
1 OFF REQUIRED
17780



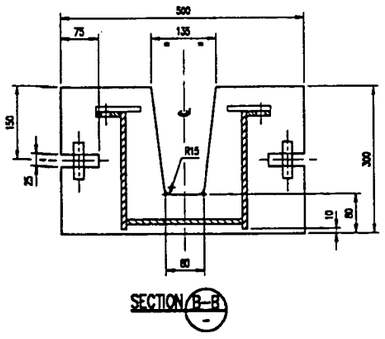


LINK PLATE DETAIL SCALE – 1:2.5
4 OFF REQUIRED

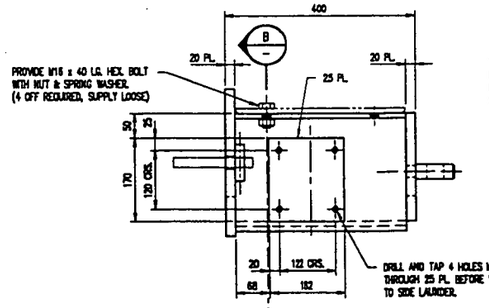


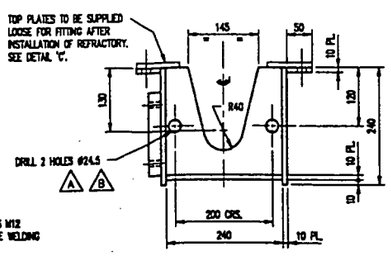


TOP PLATE – DETAIL C
2 OFF REQUIRED



SECTION B-B





LAUNDER SECTION – ITEM 2
1 OFF REQUIRED
17780

GENERAL NOTES :–

1. ALL MATERIAL TO BE MILD STEEL UNLESS NOTED OTHERWISE.
2. WELDING SHALL COMPLY WITH AS1554
3. ALL WELDS TO BE CONTINUOUS – FILLET WELDS TO BE 8mm (MIN.)
   – BUTT WELDS TO BE FULL PENETRATION.
4. REMOVE ALL BURRS AND SHARP EDGES.
5. SURFACE PREPARATION AND PAINTING SHALL BE IN ACCORDANCE WITH COMALCO STANDARD SPECIFICATION 'P1' – COATING SYSTEM 'E'.
6. ALL REFRACTORIES TO BE SUPPLIED AND INSTALLED BY COMALCO.

REVISIONS

A	ADD STUDS DELETED FROM ITEM 2 – ø28 HOLES & M24 PINS ADDED. DETAIL 'C' – 356 DIA. WAS 358.	13-11-91

EXCEPT WHERE OTHERWISE STATED
DIMENSIONS IN MILLIMETRES
TOLERANCES
MACHINED ± 0.5
FABRICATED ± 2
ANGULAR ± 1°
PROJECTION 3RD ANGLE

REFERENCE DRAWING NOS.

LAUNDER LAYOUT	17766
LAUNDER LEVEL SENSOR ARRGT & DETS.	17780
LAUNDER LEVEL CONTROL WEIR ARRGT.	17767
SKIMMER WEIR ARRGT & DETS.	17770

DISC No. 107

COMALCO ALUMINIUM (BELL BAY) LIMITED, TASMANIA

PROCESS | MAINTENANCE | SAFETY | ENG. SUPT.

DRAWN Jolly N.L. 06-11-91
CHECKED
PASSED
PROJ. ENG.
APPROVED

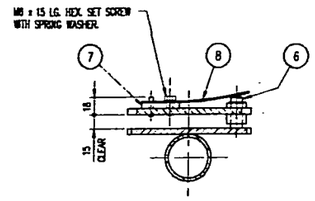
METAL PRODUCTS
INGOT CASTING
No.1 INGOT MACHINE
FEED LAUNDER DETAILS

SCALE 1:5 & AS NOTED

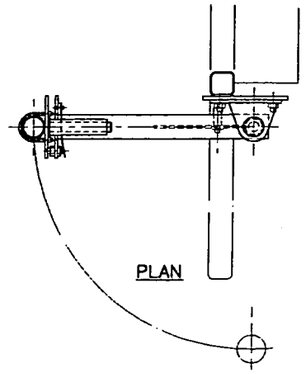
DRG.NO 17768

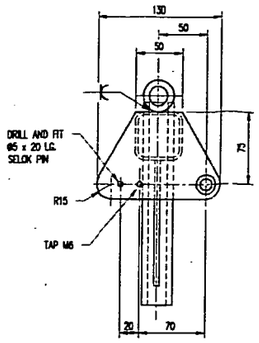
REVISION A

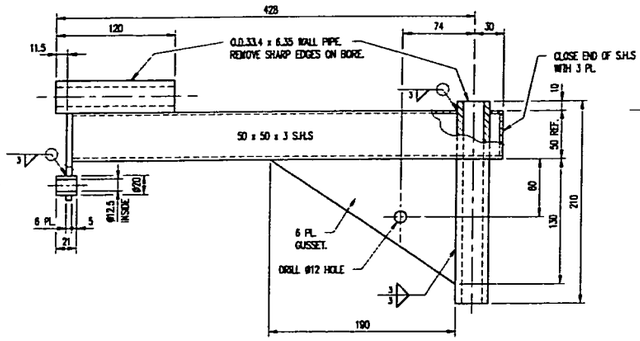
DO NOT SCALE – IF IN DOUBT – ASK



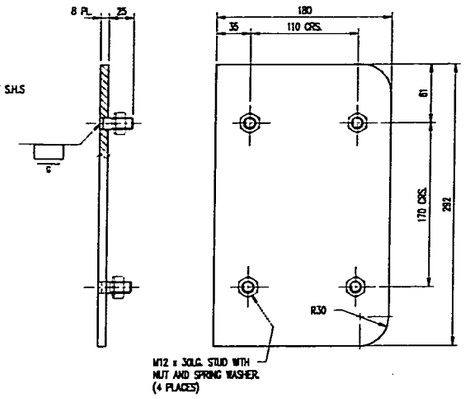
SECTION A–A
SCALE – 1:2.5



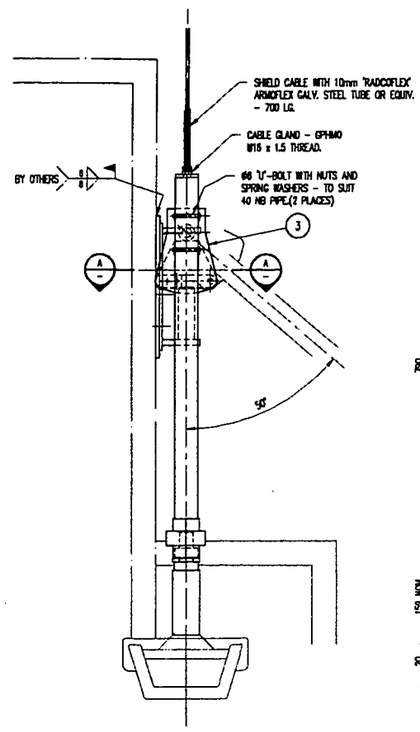


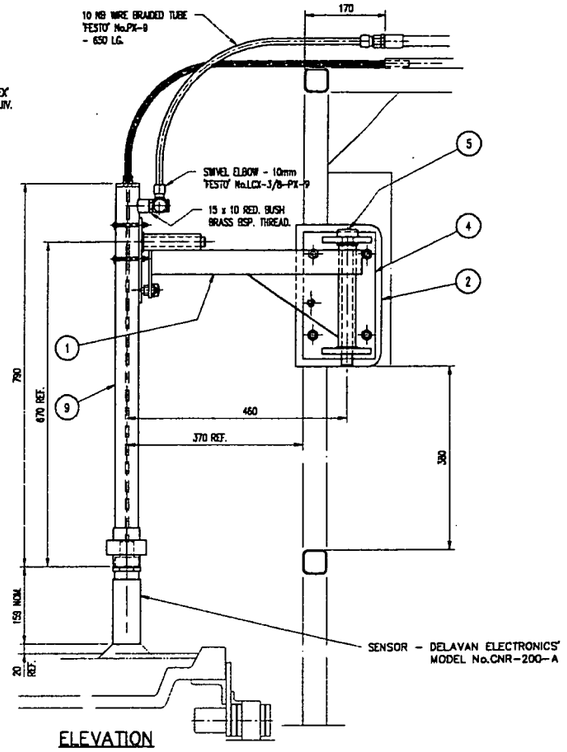


SWING ARM ITEM 1 SCALE – 1:2.5
1 OFF REQUIRED



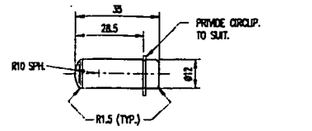
MOUNTING PLATE ITEM 2 SCALE – 1:2.5
1 OFF REQUIRED



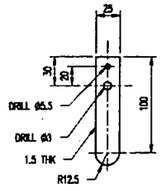


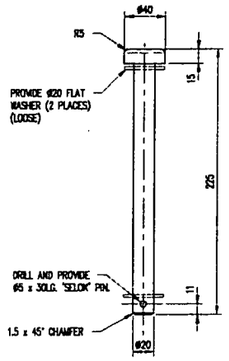
ELEVATION

INGOT HEIGHT SENSOR ASSEMBLY



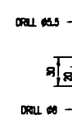
LOCKING PIN ITEM 6 SCALE – 1:1
1 OFF REQUIRED
MAT'L – BRASS



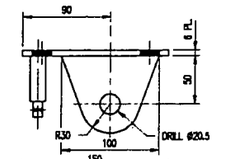


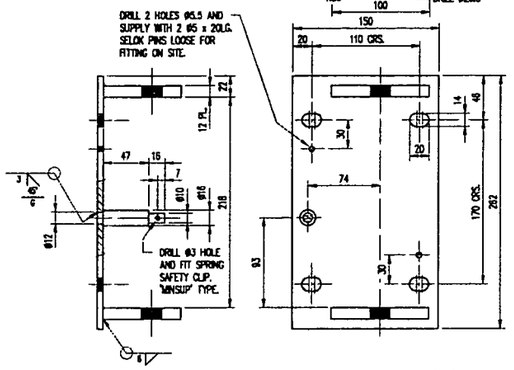
SPRING PLATE ITEM 8 SCALE – 1:2.5
1 OFF REQUIRED
MAT'L – SPRING STEEL

HINGE PIN ITEM 5 SCALE – 1:2.5
1 OFF REQUIRED
MAT'L – BRIGHT MILD STEEL

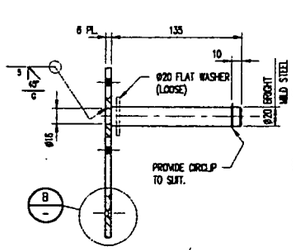


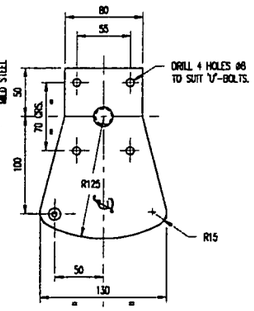
PACKER ITEM 7 SCALE – 1:2.5
1 OFF EACH REQUIRED FROM 3mm,5mm & 8mm MILD STEEL PLATE.

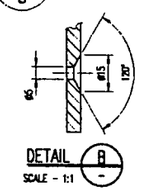




HINGE BRACKET ITEM 4 SCALE – 1:2.5
1 OFF REQUIRED

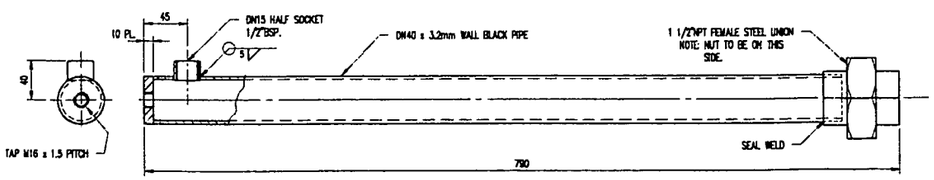






DETAIL 8
SCALE – 1:1

PIVOT PLATE ITEM 3 SCALE – 1:2.5
1 OFF REQUIRED
NOTE – TO BE SUPPLIED COMPLETE WITH 2 OFF Ø6 'U'-BOLTS WITH NUTS AND SPRING WASHERS – TO SUIT 40 NB PIPE.



SENSOR TUBE ITEM 9 SCALE – 1:2.5
1 OFF REQUIRED

GENERAL NOTES :–

1. ALL MATERIAL TO BE MILD STEEL UNLESS NOTED OTHERWISE.
2. WELDING SHALL COMPLY WITH AS1554.
3. ALL WELDS TO BE 5mm (MIN.) CONTINUOUS FILLET WELDS UNLESS NOTED OTHERWISE.
4. BUTT WELDS TO BE FULL PENETRATION.
5. REMOVE ALL BURRS AND SHARP EDGES.
6. SURFACE PREPARATION AND PAINTING SHALL BE IN ACCORDANCE WITH COMALCO STANDARD SPECIFICATION P1 – COATING SYSTEM 'F' FOR ALL MILD STEEL UNMACHINED SURFACES ONLY.
7. HINGE PIN (ITEM 5) AND PIVOT PLATE SHAFT (ITEM 3) TO BE COATED WITH SUITABLE HIGH TEMPERATURE GREASE PRIOR TO ASSEMBLY.

REVISIONS

EXCEPT WHERE OTHERWISE STATED
DIMENSIONS IN MILLIMETRES
TOLERANCES
MACHINED ± 0.5
FABRICATED ± 2
ANGULAR ± 1°
PROJECTION 3RD ANGLE

REFERENCE DRAWING NOS.

DISC No. 116

COMALCO ALUMINIUM (BELL BAY) LIMITED, TASMANIA

PROCESS		DRAWN Jolly N.L.	DATE 13-10-92
MAINTENANCE		CHECKED	
SAFETY		PASSED	
ELEC. ENG.			
ENG. DEPT.		APPROVED	

METAL PRODUCTS
INGOT CASTING
INGOT HEIGHT SENSOR ASSEMBLY AND DETAILS

SCALE 1:5 & AS NOTED

DRG.NO 21556

REVISION

Allen-Bradley Company
6200 Series Software
PLC-5 Programming Terminal Software
Release 4.4
Program Listing Report

Processor File: 06_6FNC
Wed Nov 10, 1993 - 3:38:19 pm

REPORT OPTIONS

Page Width:	80
Page Length:	66
Graphics Capabilities:	NO
Right Power Rail:	YES
Address Display:	SYMBOL
Address Comments:	YES
Rung Comments:	YES
Output Cross Reference:	NO
Ladder Cross Reference:	NONE
Starting Rung:	2:0
Ending Rung:	999:32767

ung 2:0

Jump to Subroutine No.3 (System Control)

```
+JSR---------------+
+JUMP TO SUBROUTINE+
|Prog file number 3|
|Input parameter   |
|Return parameter  |
+------------------+
```

ung 2:1

Jump to Subroutine No.4 (Hydraulic Control)

```
+JSR---------------+
+JUMP TO SUBROUTINE+
|Prog file number 4|
|Input parameter   |
|Return parameter  |
+------------------+
```

ung 2:2

Jump to Subroutine No.5 (Datataker Control)

```
+JSR---------------+
+JUMP TO SUBROUTINE+
|Prog file number 5|
|Input parameter   |
|Return parameter  |
+------------------+
```

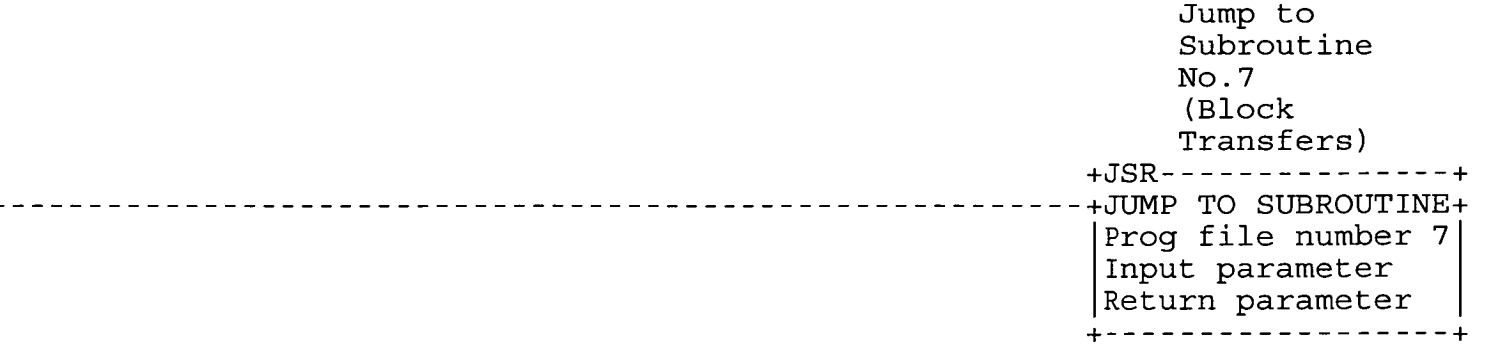
ung 2:3

Jump to Subroutine No.6 (Alarming to see)

```
+JSR---------------+
+JUMP TO SUBROUTINE+
|Prog file number 6|
|Input parameter   |
|Return parameter  |
+------------------+
```

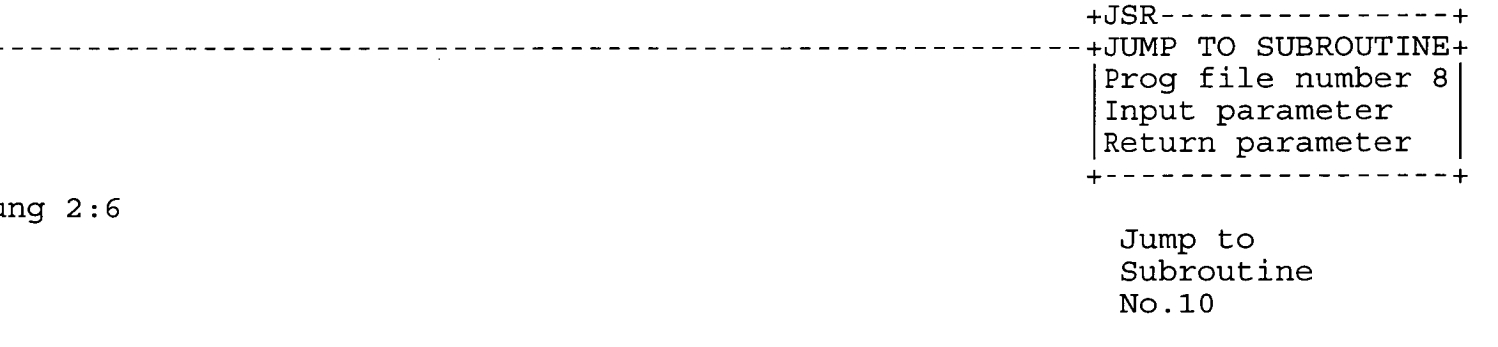
ung 2:4

Jump to Subroutine No.7 (Block Transfers)



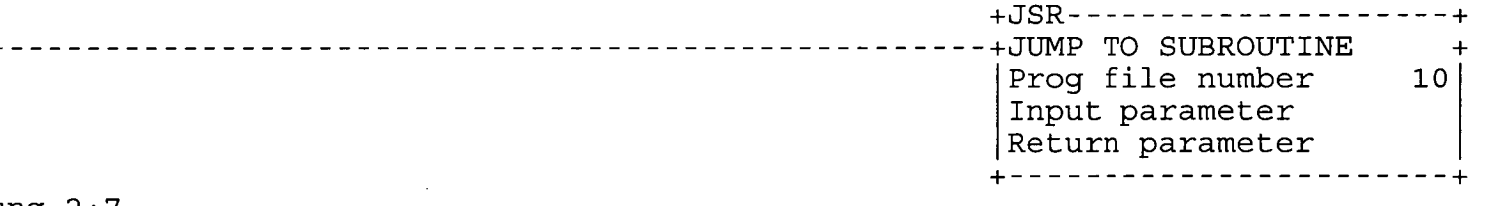
ung 2:5

Jump to Subroutine No.8 (PID Control)



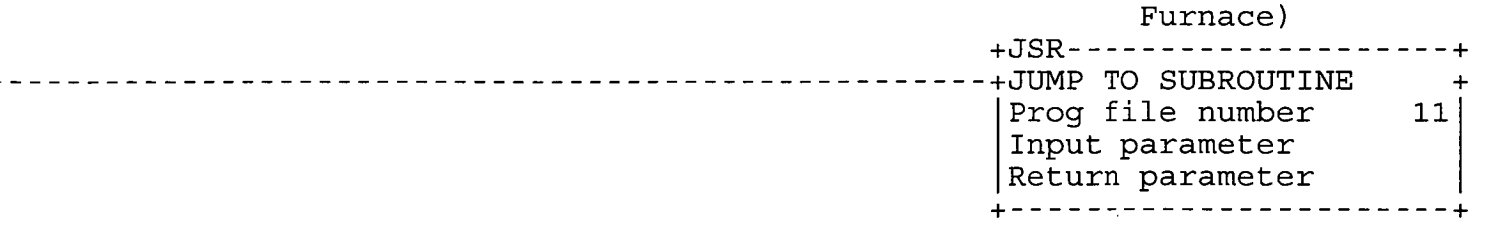
ung 2:6

Jump to Subroutine No.10



ung 2:7

Jump to Subroutine No.11 (No.7 Furnace)



ung 2:8

Jump to
Subroutine
No.12
(Ingot
Height)

```
                                        +JSR--------------------+
--------------------------------------------------------+JUMP TO SUBROUTINE     +
                                        |Prog file number     12|
                                        |Input parameter        |
                                        |Return parameter       |
                                        +-----------------------+
```

ung 2:9

Jump to
Subroutine
No.13
(Citect
Control)

```
                                        +JSR--------------------+
--------------------------------------------------------+JUMP TO SUBROUTINE     +
                                        |Prog file number     13|
                                        |Input parameter        |
                                        |Return parameter       |
                                        +-----------------------+
```

ung 2:10

[END OF FILE]

```
ung 3:0
  Input:P/B
   System
   Start
    I:010
-+---] [----+---] [-----------------------------------------------------( )----
 |     01    |     00                                                    135
 |Status:    |
 | System    |
 |  Run      |
 |    B3     |
 +---] [----+
      135
ung 3:1
                                                                  Output:
  Status:                                                         System On
   System                                                         Indication
    Run                                                            Lamp
      B3                                                           O:020
-+---] [----+-----------------------------------------------------( )----
 |     135   |                                                       01
 |Input: P/B |
 | Lamp      |
 | Test      |
 |  I:013    |
 +---] [----+
      16
ung 3:2
                                                                  Output:
  Status:                                                         System Off
   System                                                         Indication
    Run                                                            Lamp
      B3                                                           O:020
-+---]/[----+-----------------------------------------------------( )----
 |     135   |                                                       00
 |Input: P/B |
 | Lamp      |
 | Test      |
 |  I:013    |
 +---] [----+
      16
ung 3:3
          |DISPLAY
 Status:  |UPDATE                                    DISPLAY
  System  |TIMER                                     UPDATE
   Run    |DONE                                      TIMER
    B3      T4:19                                +TON---------------+
----] [--------]/[-------------------------------+TIMER ON DELAY    +-(EN)
    135         DN                               |Timer        T4:19|
                                                 |Time base      1.0+-(DN)
                                                 |Preset           2|
                                                 |Accum            0|
                                                 +------------------+
```

ung 3:4

Status: System Run B3	DISPLAY UPDATE TIMER DONE T4:19	MOVE DATA TO DISPLAY MOV MOVE
135	DN	Source N7:106 1762 Destination N7:251 1114

ung 3:5

Status: System Run B3	Input: Furnace Not Over Temp. I:010	Input: Elements Not Over Temp. I:010	Output: Furnace Elements Contactor O:020
135	10	07	05

ung 3:6

Input: Element No.1, not Tripped I:010	Input: Element No.2, not Tripped I:010	Input: Element No.3, not Tripped I:010	Input: Element No.4, not Tripped I:010	Input: Element No.5, not Tripped I:010	Input: Element No.6, not Tripped I:010	Input: Element No.7, not Tripped I:010
11	12	13	14	15	16	17

Status: Element O/Current Aux 1. B3
132

ung 3:7

Status: Element O/Current Aux 1. B3	Input: Element No.8,not Tripped I:011	Input: Element No.9, not Tripped I:011	Input: Element No.10, not Tripped I:011	Input: Element No.11, not Tripped I:011	Input: Element No.12, not Tripped I:011	Input: Element No.13, not Tripped I:011
132	00	01	02	03	04	05

Input: Element No.14, not Tripped I:011	Input: Element No.15, not Tripped I:011	Status: Element O/Current Aux 2. B3
06	07	133

ung 3:8

```
  Status:                                                                Output:
  Element                                                                Element
  O/Current                                                              O/Current
  Aux 2.                                                                 Indication
      B3                                                                 Lamp
-+---]/[----+-------------------------------------------------------------( )----
 |     133   |                                                              10
 |Input: P/B |
 | Lamp      |
 | Test      |
 |  I:013    |
 +---] [----+
        16
```

ung 3:9

```
             |Output:    |Input:                                                 Output:
 Status:     |Furnace    |Main Door                                                SCR
  System     |Elements   |Closed                                                 Control
   Run       |Contactor  |Prox.                                                  Relay
    B3       |  O:020    |  I:012                                                O:021
----] [--------] [--------] [-------------------------------------------------( )----
    135          05         15                                                    15
```

ung 3:10

```
 Input:      |Input:     |Output:    |                          Timer:
   SCR       |Main C/B   |  SCR      |Status:                   Validate
 Blown Fuse  |Closed     | Control   | System                   SCR Fault
   Relay     |           | Relay     |  Run
   I:027     |  I:010    |  O:021    |   B3              +TON---------------+
----] [--------] [--------] [--------] [-------------+TIMER ON DELAY    +-(EN)
     04          03         15         135           |Timer         T4:14|
                                                     |Time base       1.0+-(DN)
                                                     |Preset            1|
                                                     |Accum             0|
                                                     +-------------------+
```

ung 3:11

```
                                                                  Output:
                                                                  SCR Blown
  Timer:                                                            Fuse
  Validate                                                        Indication
  SCR Fault                                                         Lamp
    T4:14                                                         O:025
-+---] [----+-------------------------------------------------------( )----
 |      DN   |                                                        00
 | Input:    |
 | Main C/B  |
 | Closed    |
 |           |
 |  I:010    |
 +---]/[----+
 |      03   |
 | Input: P/B|
 |  Lamp     |
 |  Test     |
 |  I:013    |
 +---] [----+
        16
```

ung 3:12

```
 Input:     |Status:    |                                                Status:
 No.1 Ingot |No.2 Ingot |Status:                                         No.1 Ingot
 Station    |Station    | System                                         Station
 Selected   |Master     |  Run                                           Master
   I:027         B3          B3                                            B3
----] [--------]/[--------] [-----------------------------------------( )----
      05         129         135                                           128
```

ung 3:13

```
 Input:     |Status:    |                                                Status:
 No.2 Ingot |No.1 Ingot |Status:                                         No.2 Ingot
 Station    |Station    | System                                         Station
 Selected   |Master     |  Run                                           Master
   I:027         B3          B3                                            B3
----] [--------]/[--------] [-----------------------------------------( )----
      06         128         135                                           129
```

ung 3:14

```
                                                                  Output:
 Status:                                                          Select
 No.2 Ingot                                                       No.2 M/C
 Station                                                          Tilt
 Master                                                           Relay
     B3                                                            O:025
----] [-------------------------------------------------------------( )----
     129                                                             04
```

ung 3:15

```
            |Input:     |Input:
 Input:     |Hot Metal  | Crucible
 Main Door  |Door       | Table                                          Status:
 Closed     |Closed     | Home                                           Clear To
 Prox.      |Prox       | Prox                                           Tilt
   I:012       I:013       I:027                                           B3
----] [--------] [--------] [-----------------------------------------( )----
      15          03          01                                           136
```

ung 3:16

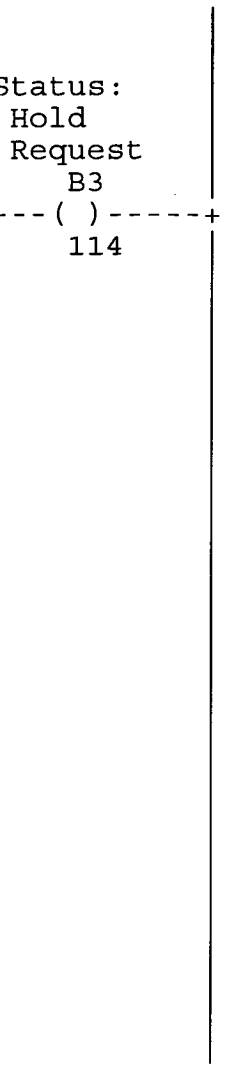
Input: Fast Tilt Pushbutton At No.1 Machine I:012 10	Input: Furnace Lower Sw. At No.1 Machine I:012 06	Status: No.1 Ingot Station Master B3 128	Status: Clear To Tilt B3 136	Status: Fast Raise Request B3 112
Input: Fast Tilt Pushbutton At No.2 Machine I:027 16	Input: Furnace 6 Lower Sw. At No.2 Machine I:027 15	Status: No.2 Ingot Station Master B3 129		
Timer: Pulse Raise Furnace T4:11 EN				

ung 3:17

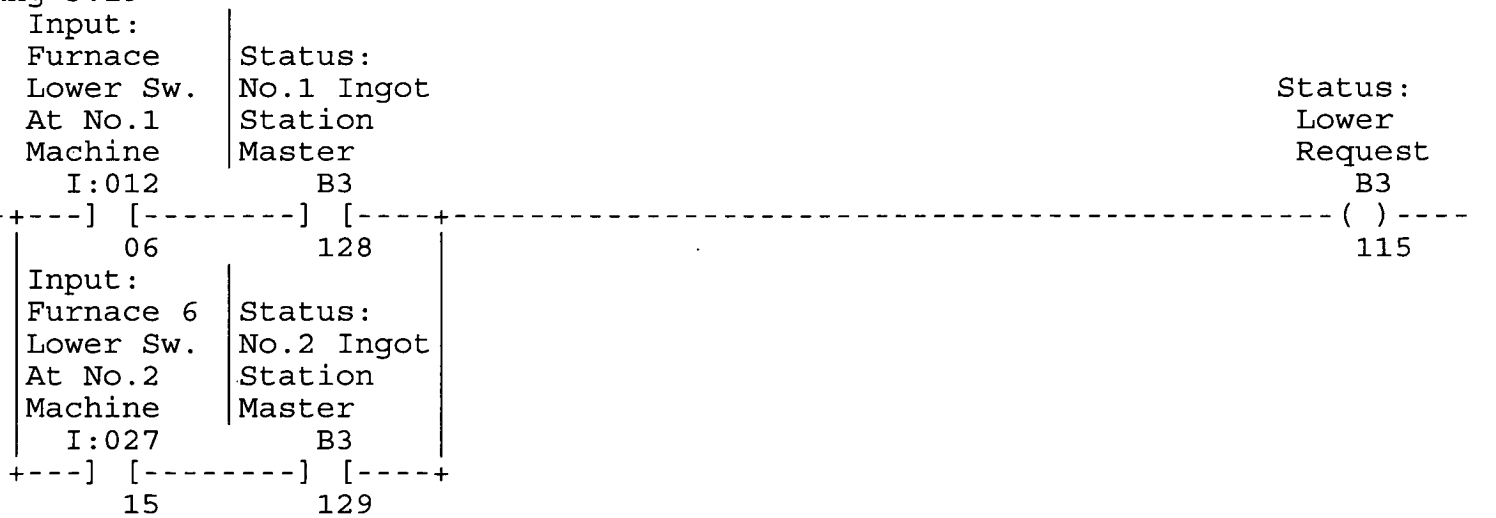
Input: Furnace Raise Sw. At No.1 Machine I:012 05	Input: Furnace Lower Sw. At No.1 Machine I:012 06	Status: No.1 Ingot Station Master B3 128	Status: Clear To Tilt B3 136	Status: Slow Raise Request B3 113
Input: Furnace 6 Raise Sw. At No.2 Machine I:027 12	Input: Furnace 6 Lower Sw. At No.2 Machine I:027 15	Input: Automatic Tilt No.6 Select At No.2 M/C I:027 14	Status: No.2 Ingot Station Master B3 129	

ung 3:18

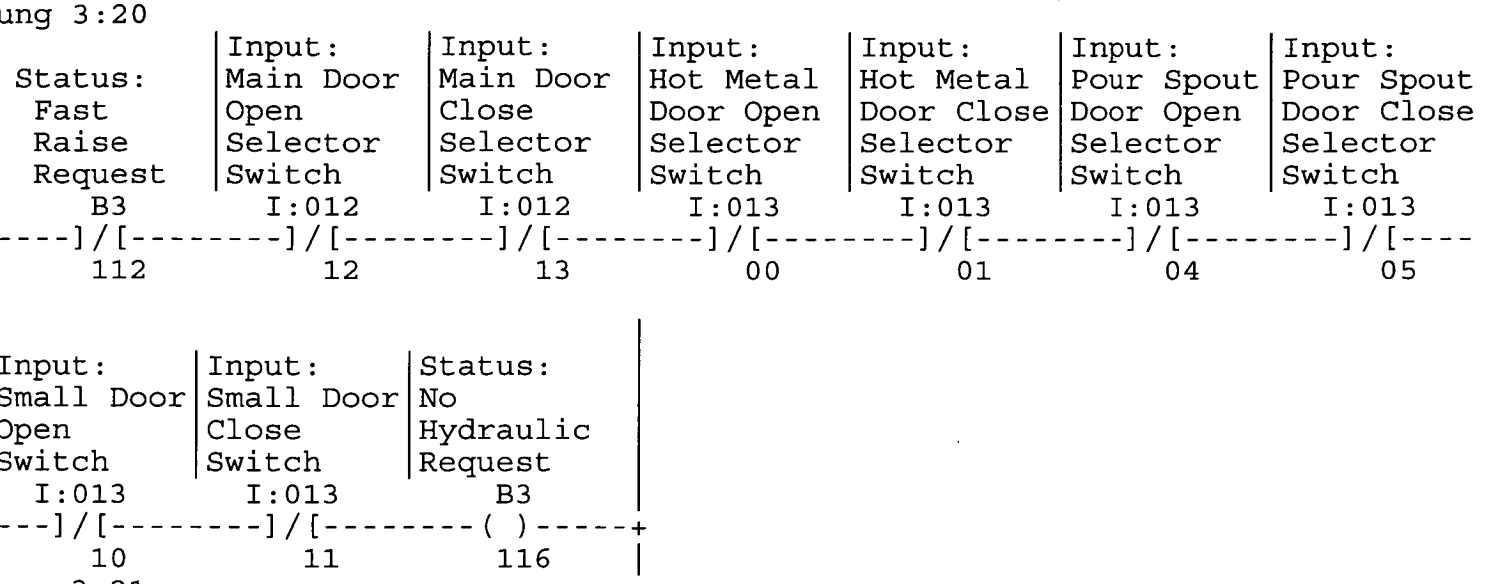
Input: Furnace Raise Sw. At No.1 Machine	Input: Furnace Lower Sw. At No.1 Machine	Status: No.1 Ingot Station Master			
I:012	I:012	B3			
]/[	]/[	] [			
05	06	128			
Input: Furnace 6 Raise Sw. At No.2 Machine	Input: Furnace 6 Lower Sw. At No.2 Machine	Status: No.2 Ingot Station Master			
I:027	I:027	B3			
]/[	]/[	] [			
12	15	129			
Input: Furnace Raise Sw. At No.1 Machine	Input: Furnace Lower Sw. At No.1 Machine	Input:No.6 Automatic Tilt Select At No.1 M/C XIO	Input:No.7 Automatic Level Select At No.1 M/C	Status: No.1 Ingot Station Master	Input: Fast Tilt Pushbutton At No.1 Machine
I:012	I:012	I:027	I:027	B3	I:012
] [	]/[	]/[	]/[	] [	]/[
05	06	07	10	128	10
Input: Furnace 6 Raise Sw. At No.2 Machine	Input: Furnace 6 Lower Sw. At No.2 Machine	Input: Manual Tilt No.6 Select At No.2 M/C	Status: No.2 Ingot Station Master	Input: Fast Tilt Pushbutton At No.2 Machine	
I:027	I:027	I:027	B3	I:027	
] [	]/[	] [	] [	]/[	
12	15	13	129	16	


Status:
Hold
Request
B3
( )
114

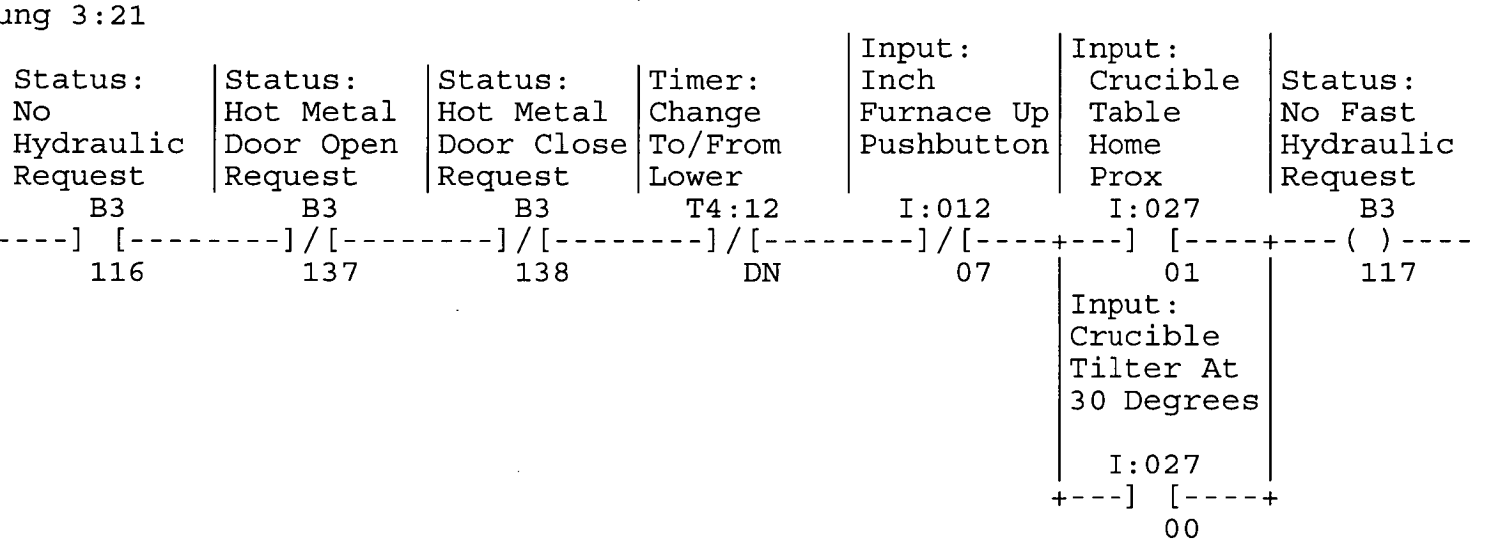
ung 3:19


Input:
Furnace
Lower Sw.
At No.1
Machine
I:012
06
Status:
No.1 Ingot
Station
Master
B3
128
Status:
Lower
Request
B3
115
Input:
Furnace 6
Lower Sw.
At No.2
Machine
I:027
15
Status:
No.2 Ingot
Station
Master
B3
129

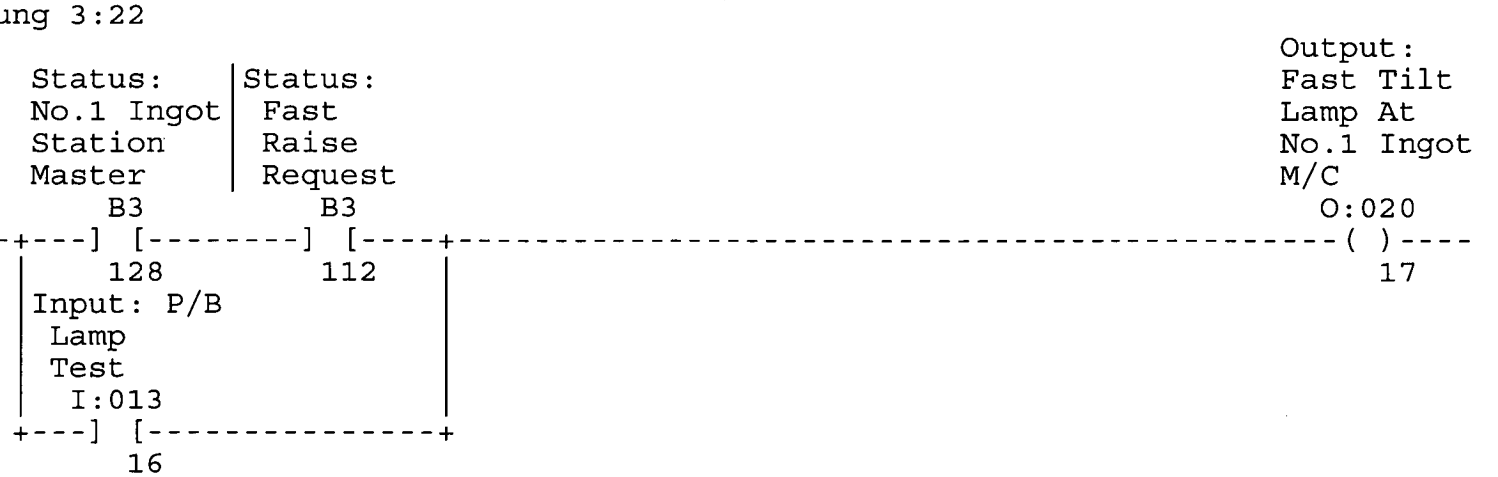
ung 3:20



ung 3:21



ung 3:22



ung 3:23

```
 Status:    |Status:                                                  Output:
 No.1 Ingot | Slow                                                    Slow Tilt
 Station    | Raise                                                   Lamp At
 Master     | Request                                                 No.2 Ingot
     B3          B3                                                   M/C
+---] [--------] [----+-------------------------------------------( )----
|    128         113  |                                               01
|Input: P/B           |
| Lamp                |
| Test                |
|  I:013              |
+---] [---------------+
      16
```

ung 3:24

```
 Status:    |Status:                                                  Output:
 No.1 Ingot | Fast                                                    Furnace
 Station    | Raise                                                   Raise Lamp
 Master     | Request                                                 At No.1
     B3          B3                                                   Ingot M/C
+---] [--------] [----+-------------------------------------------( )----
|    128         112  |                                               14
|Status:     |Status: |
|No.1 Ingot  | Slow   |
|Station     | Raise  |
|Master      | Request|
|    B3          B3  |
+---] [--------] [----+
|    128         113  |
|Input: P/B           |
| Lamp                |
| Test                |
|  I:013              |
+---] [---------------+
      16
```

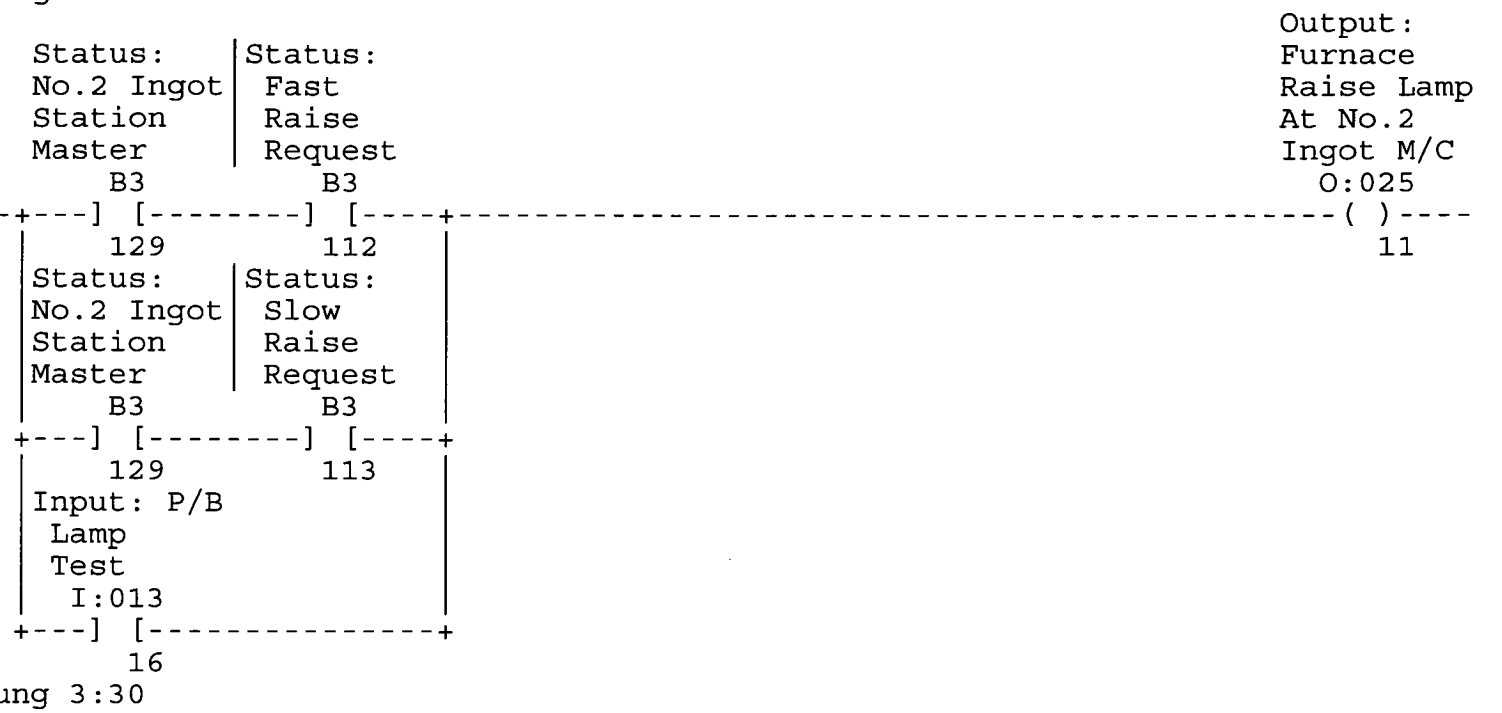
ung 3:25

```
 Status:    |                                                         Output:
 No.1 Ingot |Status:                                                  Furnace
 Station    | Lower                                                   Lower Lamp
 Master     | Request                                                 At No.1
     B3          B3                                                   Ingot M/C
+---] [--------] [----+-------------------------------------------( )----
|    128         115  |                                               15
|Input: P/B           |
| Lamp                |
| Test                |
|  I:013              |
+---] [---------------+
      16
```

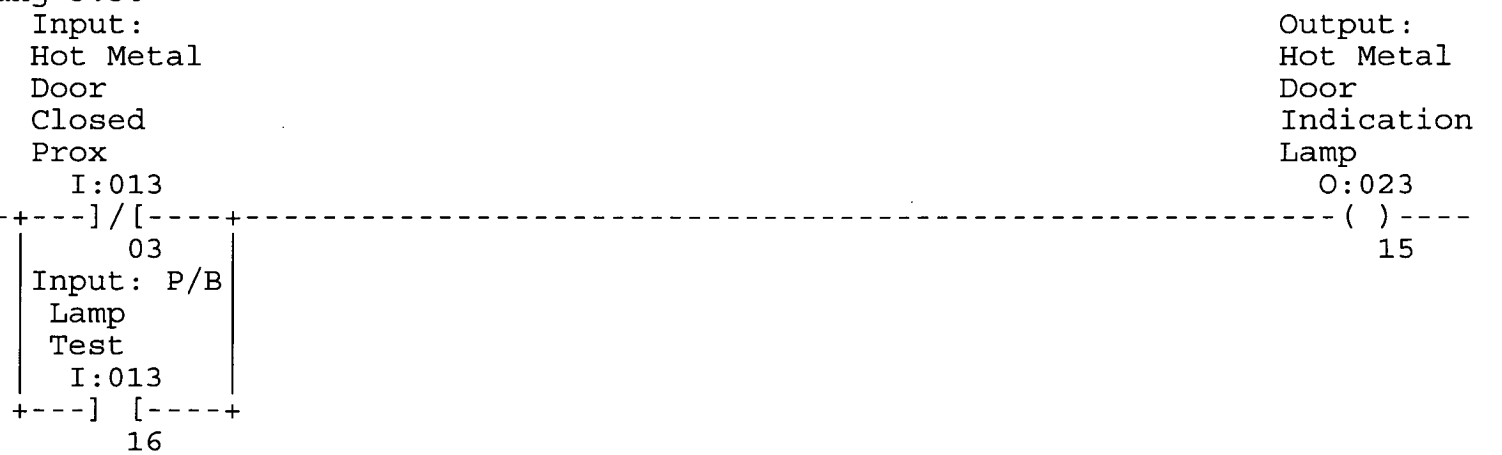
ung 3:26

```
                |Output:    |Output:    |                                  Output:
  Status:       |Furnace    |Furnace    |                                  Furnace
  No.1 Ingot    |Raise Lamp |Lower Lamp |Status:                           Hold Lamp
  Station       |At No.1    |At No.1    | Hold                             At No.1
  Master        |Ingot M/C  |Ingot M/C  | Request                          Ingot M/C
      B3          O:020       O:020         B3                               O:021
-+---] [--------]/[--------]/[--------] [----+-------------------------( )----
 |    128          14          15          114   |                          02
 |Input: P/B                                     |
 | Lamp                                          |
 | Test                                          |
 |  I:013                                        |
 +---] [---------------------------------------+
       16
ung 3:27
                                                                         Output:
  Status:       |Status:                                                 Furnace
  No.2 Ingot    | Fast                                                   Fast Tilt
  Station       | Raise                                                  At No.2
  Master        | Request                                                Ingot M/C
      B3          B3                                                     O:025
-+---] [--------] [----+-------------------------------------------------( )----
 |    129          112   |                                                06
 |Input: P/B             |
 | Lamp                  |
 | Test                  |
 |  I:013                |
 +---] [---------------+
       16
ung 3:28
                                                                         Output:
  Status:       |Status:                                                 Furnace
  No.2 Ingot    | Slow                                                   Slow Tilt
  Station       | Raise                                                  At No.2
  Master        | Request                                                Ingot M/C
      B3          B3                                                     O:025
-+---] [--------] [----+-------------------------------------------------( )----
 |    129          113   |                                                07
 |Input: P/B             |
 | Lamp                  |
 | Test                  |
 |  I:013                |
 +---] [---------------+
       16
```

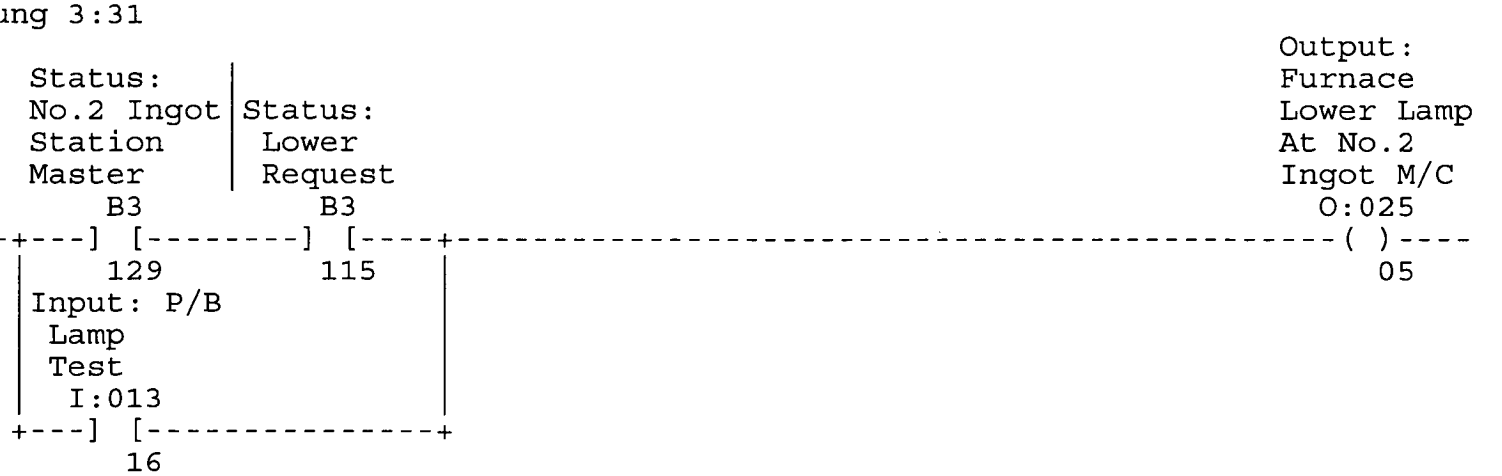
ung 3:29



ung 3:30



ung 3:31



ung 3:32

```
                                                                                    Output:
  Status:  |                                                                        Furnace
  No.2 Ingot|Status:                                                               Hold Lamp
  Station   | Hold                                                                 At No.2
  Master    | Request                                                              Ingot M/C
      B3          B3                                                                O:025
-+---] [--------] [----+-------------------------------------------------------( )----
 |     129         114  |                                                           10
 |Input: P/B            |
 | Lamp                 |
 | Test                 |
 |  I:013               |
 +---] [---------------+
       16
```

ung 3:33

```
                                                                                    Output:
  Input:    |Status:                                                               Main Door
  Main Door |Flash                                                                 Open
  Closed    |Timer                                                                 Indication
  Prox.     |Bit                                                                   Lamp
    I:012         B3                                                                O:023
-+---]/[--------] [----+-------------------------------------------------------( )----
 |     15          134  |                                                           14
 |Input: P/B            |
 | Lamp                 |
 | Test                 |
 |  I:013               |
 +---] [---------------+
       16
```

ung 3:34

```
 Output:                                                                            Output:
 Main Door                                                                          Main Door
 Open                                                                               Open Mimic
 Indication                                                                         Indication
 Lamp                                                                               Lamp
   O:023                                                                              O:025
----] [-----------------------------------------------------------------------( )----
      14                                                                              01
```

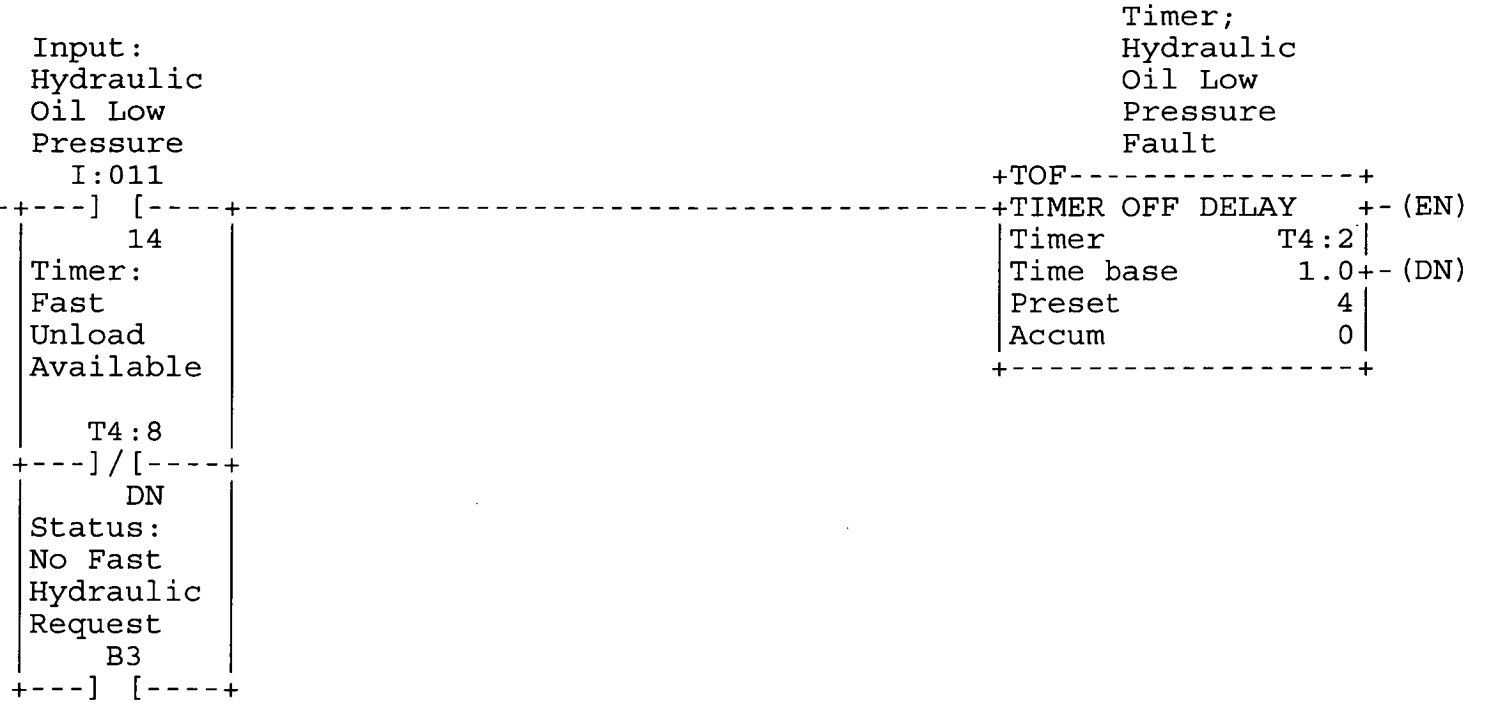
ung 3:35

```
  Input:
   Crucible                                                                         Output:
   Table                                                                            Cruc. Tilt
   Home                                                                             Table Up
   Prox                                                                             Lamp
    I:027                                                                             O:023
-+---]/[----+-------------------------------------------------------------------( )----
 |     01    |                                                                     17
 |Input: P/B |
 | Lamp      |
 | Test      |
 |  I:013    |
 +---] [----+
       16
```

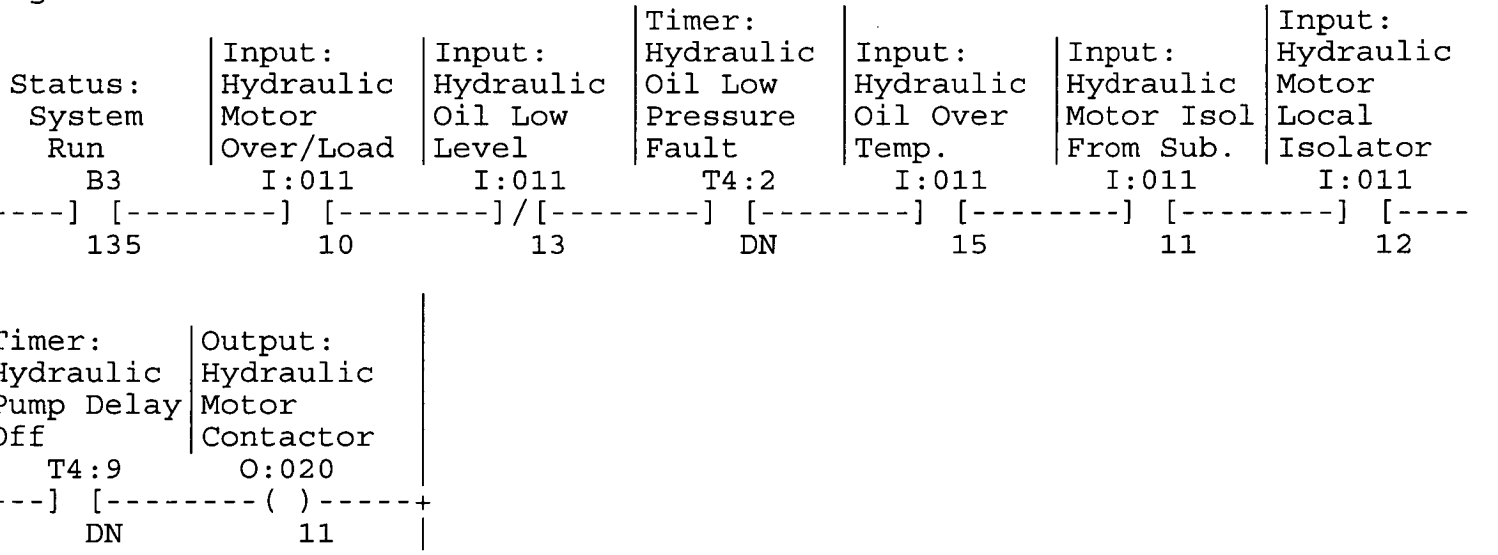
```
ung 3:36
  Input:                                                          Output:
  Hot Metal                                                       Hot Metal
  Door                                                            Door
  Closed                                                          Indication
  Prox                                                            Lamp
    I:013                                                           O:023
-+---]/[----+-------------------------------------------------------( )----
 |      03   |                                                        15
 |Input: P/B |
 | Lamp      |
 | Test      |
 |  I:013    |
 +---] [----+
       16
ung 3:37
```

[END OF FILE]

ung 4:0

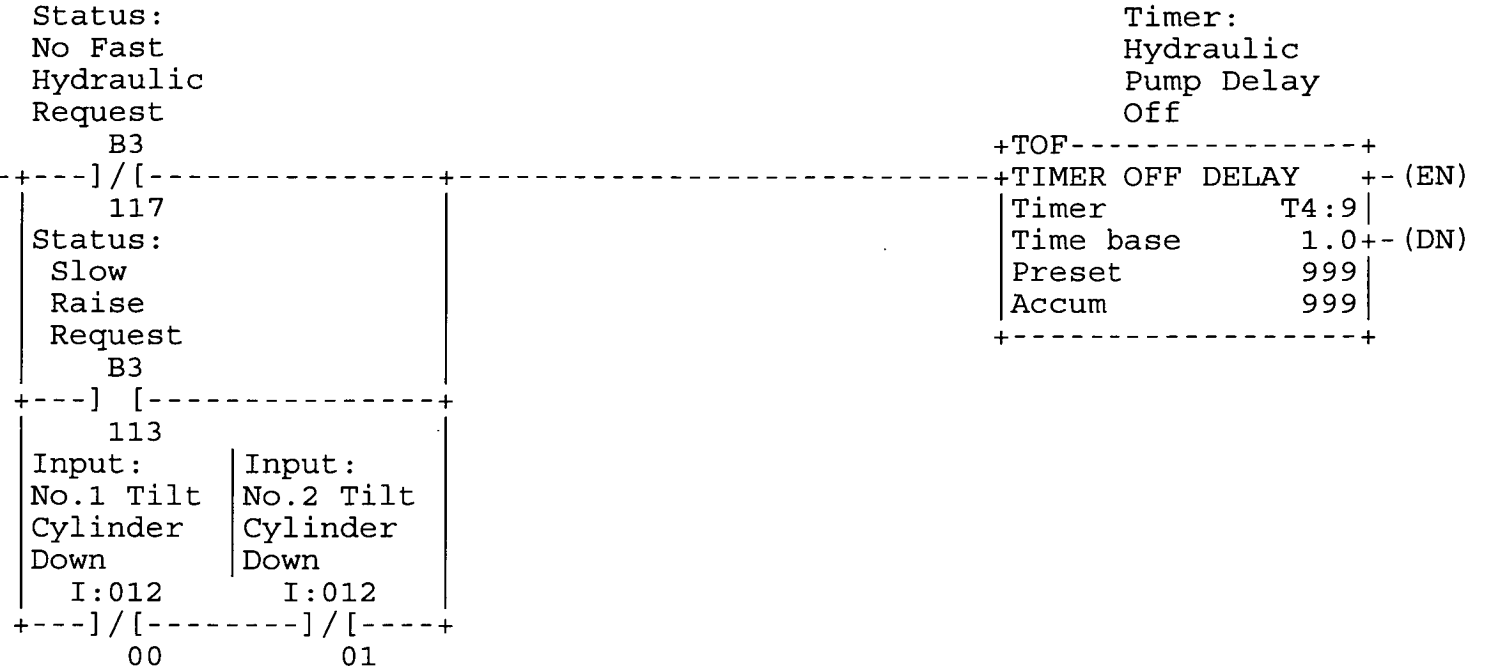

Input:
Hydraulic
Oil Low
Pressure
I:011
14
Timer:
Fast
Unload
Available
T4:8
DN
Status:
No Fast
Hydraulic
Request
B3
117
Timer;
Hydraulic
Oil Low
Pressure
Fault
TOF
TIMER OFF DELAY
Timer T4:2
Time base 1.0
Preset 4
Accum 0
EN
DN

ung 4:1

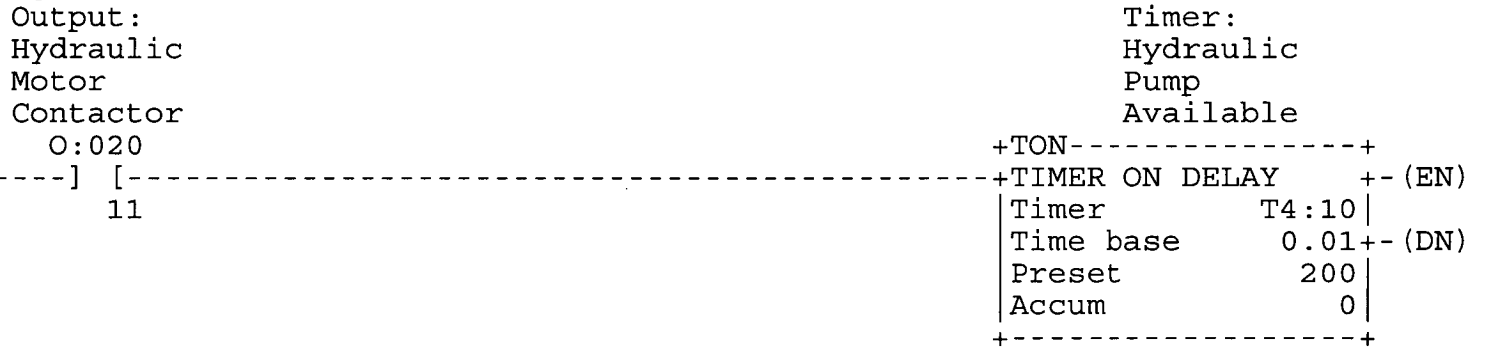

Status:
System
Run
B3
135
Input:
Hydraulic
Motor
Over/Load
I:011
10
Input:
Hydraulic
Oil Low
Level
I:011
13
Timer:
Hydraulic
Oil Low
Pressure
Fault
T4:2
DN
Input:
Hydraulic
Oil Over
Temp.
I:011
15
Input:
Hydraulic
Motor Isol
From Sub.
I:011
11
Input:
Hydraulic
Motor
Local
Isolator
I:011
12

Timer:
Hydraulic
Pump Delay
Off
T4:9
DN
Output:
Hydraulic
Motor
Contactor
O:020
11

ung 4:2



ung 4:3



ung 4:4

ung 4:5

```
 Timer:      |Timer:                                                    Output:
 Slow        |Hydraulic                                                 Slow Tilt
 Unload Off  |Pump                                                      Speed Dump
             |Available                                                 Solenoid
    T4:6       T4:10                                                     O:021
----] [--------] [-----------------------------------------------------( )----
      DN         DN                                                       00
```

ung 4:6

```
 Output:
 Slow Tilt
 Speed Dump
 Solenoid                                                    Timer:
                                                             Slow Pump
                                                             Available
   O:021                                                  +TON---------------+
----] [-------------------------------------------------+TIMER ON DELAY    +-(EN)
      00                                                 |Timer          T4:1|
                                                         |Time base      0.01+-(DN)
                                                         |Preset          200|
                                                         |Accum             0|
                                                         +------------------+
```

ung 4:7

```
  Status:                                                    Timer:
  No Fast                                                    Fast Tilt
  Hydraulic                                                  Unload
  Request                                                    Valve Off
      B3                                                 +TOF---------------+
-+---]/[-------------------------+-----------------+TIMER OFF DELAY   +-(EN)
 |    117                        |                 |Timer          T4:7|
 |Timer:     |Timer:             |                 |Time base       1.0+-(DN)
 |Pulse      |Pulse              |                 |Preset            5|
 |Raise      |Raise              |                 |Accum             5|
 |Furnace    |Timer              |                 +------------------+
 |  T4:11      T4:11           |
 +---] [--------]/[--------------+
 |     EN          DN          |
 |           |Input:     |Input: |
 |Status:    |No.1 Tilt  |No.2 Tilt
 | Lower     |Cylinder   |Cylinder
 | Request   |Down       |Down
 |    B3       I:012       I:012 |
 +---] [--------]/[--------]/[----+
       115         00          01
```

ung 4:8

```
 Timer:      |Timer:                                                    Output:
 Fast        |Hydraulic                                                 Fast Tilt
 Unload      |Pump                                                      Speed Dump
 Valve Off   |Available                                                 Solenoid
    T4:7       T4:10                                                     O:020
----] [--------] [-----------------------------------------------------( )----
      DN         DN                                                       16
```

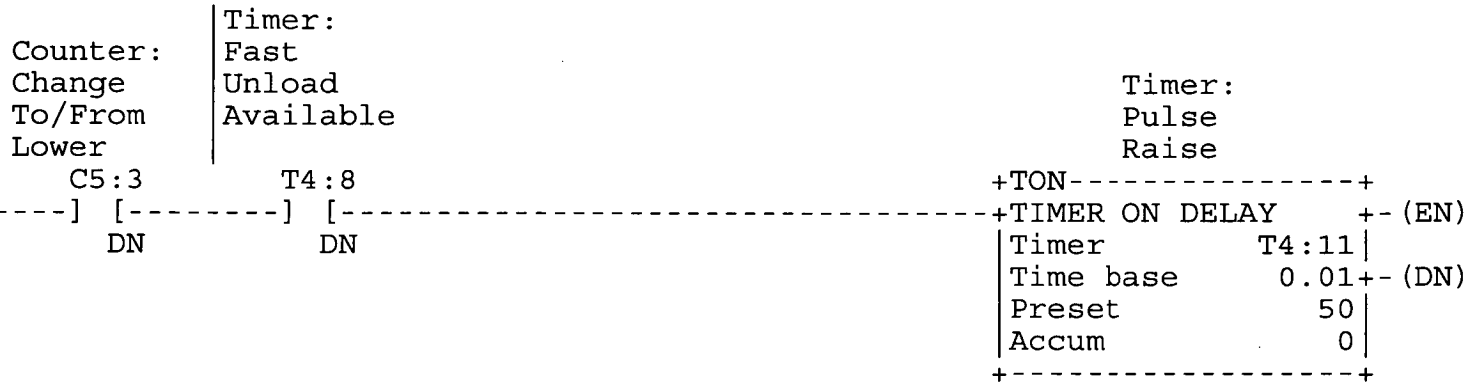
```
ung 4:9
 Output:
 Fast Tilt
 Speed Dump
 Solenoid

   O:020                                                    +TON---------------+
----] [-----------------------------------------------------+TIMER ON DELAY    +-(EN)
      16                                                    |Timer         T4:8|
                                                            |Time base     0.01+-(DN)
                                                            |Preset          50|
                                                            |Accum            0|
                                                            +------------------+
ung 4:10
             |Status:                                        Counter:
  Status:    |Lower                                          Change
   Lower     |Operation                                      To/From
   Request   |Auxiliary                                      Lower
      B3          B3                                        +CTU---------------+
-+---] [--------]/[----+-----------------------------------+COUNT UP           +-(CU)
 |    115         118   |                                   |Counter       C5:3|
 |            |Status:   |                                   |Preset           1+-(DN)
 |Status:     |Lower     |                                   |Accum            0|
 | Lower      |Operation |                                   +------------------+
 | Request    |Auxiliary |
 |    B3          B3     |
 +---]/[--------] [----+
      115         118
ung 4:11
 Timer:                                                                  Counter:
 Pulse                                                                   Change
 Raise                                                                   To/From
 Timer                                                                   Lower
   T4:11                                                                    C5:3
----] [-----------------------------------------------------------------(RES)---
      DN
ung 4:12
```

equired to generate a pulse to a counter (works because of PLC scanning mode:

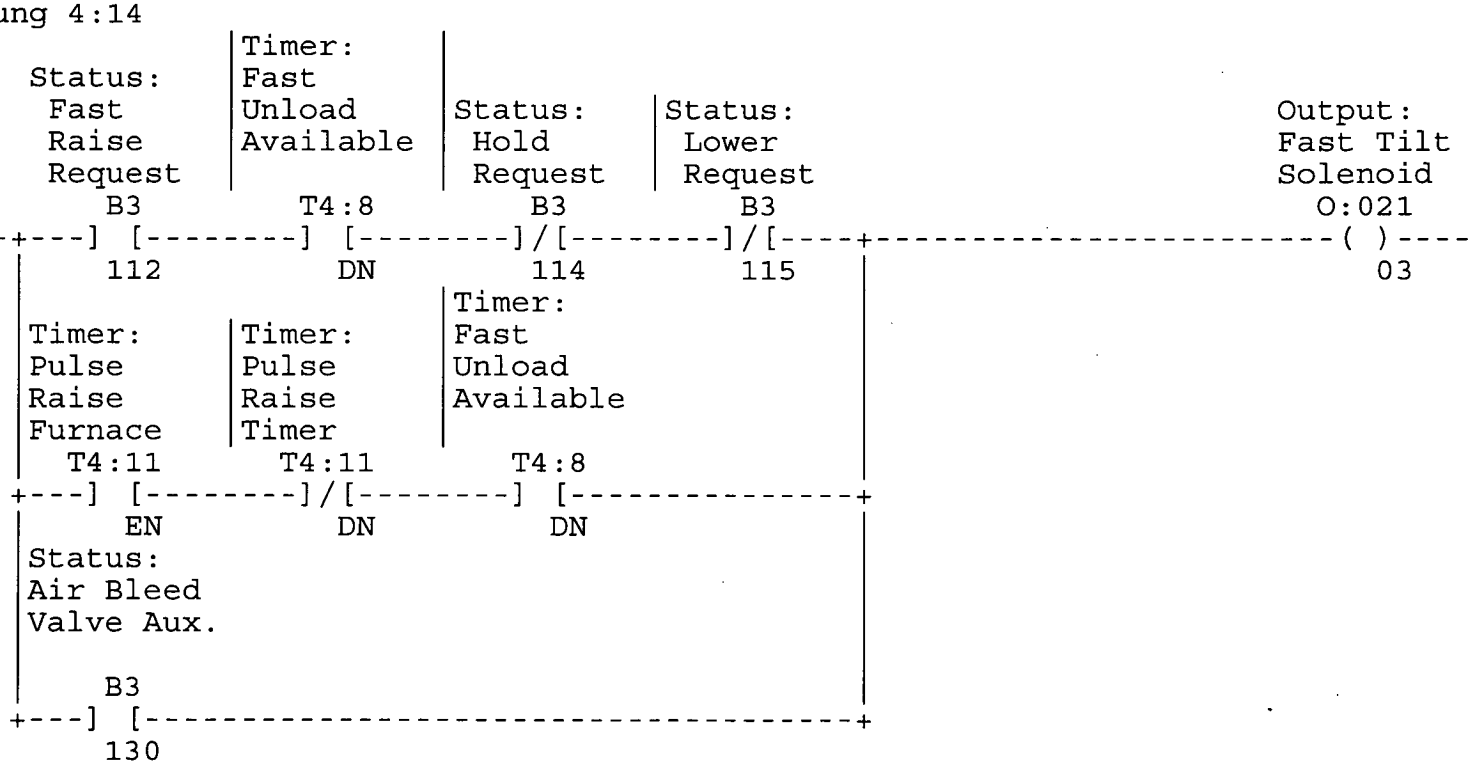
```
                                                                         Status:
 Status:                                                                 Lower
  Lower                                                                  Operation
  Request                                                                Auxiliary
     B3                                                                      B3
----] [-----------------------------------------------------------------( )----
     115                                                                     118
```

ung 4:13

equired to ensure hydraulics transfer To and From Lower mode activation of th
ilot valves.



ung 4:14



ung 4:15

```
  Output:                  Status:                                                    Output:
  Fast Tilt                 Lower                                                     Furnace
  Solenoid                  Request                                                   Raise
    O:021                     B3                                                     Solenoid
-+---] [-----------------+---]/[-----------------------------------------( )----     O:020
 |      03               |     115                                                    13
 |Status:    |           |
 | Slow      |Timer:     |
 | Raise     |Slow Pump  |
 | Request   |Available  |
 |    B3        T4:1     |
 +---] [--------] [----+  |
 |     113         DN    |
 |Status:                |
 | Hold                  |
 | Request               |
 |    B3                 |
 +---] [-----------------+
       114
```

ung 4:16

```
                          |Timer:
 Input:                   |Fast                                                      Output:
 Small Door |Input:       |Unload                                                    Small Door
 Open       |Small Door   |Available                                                 Open
 Switch     |Open Prox    |                                                          Solenoid
   I:013       I:013          T4:8                                                    O:021
----] [--------]/[--------] [-----------------------------------------( )----
      10          12            DN                                                    12
```

ung 4:17

```
                          |Timer:
 Input:     |Input:       |Fast                                                      Output:
 Small Door |Small Door   |Unload                                                    Small Door
 Close      |Closed       |Available                                                 Close
 Switch     |Prox         |                                                          Solenoid
   I:013       I:013          T4:8                                                    O:021
----] [--------]/[--------] [-----------------------------------------( )----
      11          13            DN                                                    13
```

ung 4:18

```
 Input:                   |Timer:
 Pour Spout |Input:       |Fast                                                      Output:
 Door Open  |Pour Spout   |Unload                                                    Pour Spout
 Selector   |Door Open    |Available                                                 Door Open
 Switch     |Prox         |                                                          Solenoid
   I:013       I:013          T4:8                                                    O:021
----] [--------]/[--------] [-----------------------------------------( )----
      04          06            DN                                                    10
```

```
ung 4:19
 Input:      |Input:      |Timer:
 Pour Spout  |Pour Spout  |Fast                                          Output:
 Door Close  |Door Close  |Unload                                        Pour Spout
 Selector    |Sel.Switch  |Available                                     Door Close
 Switch      |            |                                              Solenoid
   I:013       I:013        T4:8                                         O:021
----] [--------]/[--------] [-------------------------------------------( )----
      05          07           DN                                          11
ung 4:20
 Timer:      |
 Fast        |Input:      |Input:                                        Status:
 Unload      |No.1 Tilt   |No.2 Tilt                                     O.K. To
 Available   |Cylinder    |Cylinder                                      Operate
             |Down        |Down                                          Doors
    T4:8       I:012        I:012                                          B3
----] [--------] [--------] [-------------------------------------------( )----
      DN          00           01                                          119
ung 4:21
 Input:      |
 Main Door   |            |Status:                                       Output:
 Open        |Input:      |O.K. To                                       Main Door
 Selector    |Main Door   |Operate                                       Open
 Switch      |Open Prox   |Doors                                         Solenoid
   I:012       I:012        B3                                           O:021
----] [--------]/[--------] [-------------------------------------------( )----
      12          14           119                                         04
ung 4:22
 Input:      |            |Timer:
 Main Door   |Input:      |Fast                                          Output:
 Close       |Main Door   |Unload                                        Main Door
 Selector    |Closed      |Available                                     Close
 Switch      |Prox.       |                                              Solenoid
   I:012       I:012        T4:8                                         O:021
----] [--------]/[--------] [-------------------------------------------( )----
      13          15           DN                                          05
```

ung 4:23

```
  Input:
  Crucible
  Table Home
  Prox
    I:027                                                    Timer:
-+---]/[----+-------------------------------------------+TOF---------------+
 |      03   |                                           |TIMER OFF DELAY   +-(EN)
 |Input:     |                                           |Timer         T4:5|
 | Crucible  |                                           |Time base      1.0+-(DN)
 | Table     |                                           |Preset          60|
 | Home      |                                           |Accum           60|
 | Prox      |                                           +------------------+
 |  I:027    |
 +---]/[----+
 |      01   |
 |Input:     |
 |Heat       |
 |Sensor At  |
 |Hot Metal  |
 |Door       |
 |  I:027    |
 +---] [----+
 |      02   |
 |Input:     |
 |Hot Metal  |
 |Door Open  |
 |Selector   |
 |Switch     |
 |  I:013    |
 +---] [----+
        00
```

ung 4:24

```
  Input:      |            |Input:      |                                  Status:
  Hot Metal   |Timer:      |Hot Metal   |Input:                            Hot Metal
  Door Close  |Hold Hot    |Door Open   |Crucible                          Door Man.
  Selector    |Metal Door  |Selector    |Table Home                        Close
  Switch      |Open        |Switch      |Prox                                  B3
    I:013        T4:5         I:013        I:027                              ( )
-+---] [----+---] [--------]/[--------] [-------------------------------(  )----
 |      01   |      DN           00           03                              131
 |Status:    |
 |Hot Metal  |
 |Door Man.  |
 |Close      |
 |    B3     |
 +---] [----+
       131
```

ung 4:25

```
 Timer:      |Input:      |Status:                                          Status:
 Hold Hot    |Hot Metal   |Hot Metal                                        Hot Metal
 Metal Door  |Door Open   |Door Man.                                        Door Open
 Open        |Prox        |Close                                            Request
    T4:5         I:013         B3                                              B3
----] [--------]/[--------]/[-----------------------------------------------(  )----
       DN           02           131                                           137
```

```
ung 4:26
 Status:    |Status:                                                    Output:
 Hot Metal  |O.K. To                                                    Hot Metal
 Door Open  |Operate                                                    Door Open
 Request    |Doors                                                      Solenoid
     B3          B3                                                     O:021
----] [--------] [-----------------------------------------------------( )----
     137         119                                                      06
ung 4:27
            |Input:     |Input:
  Status:   |Hot Metal  | Crucible                                      Status:
  Hot Metal |Door       | Table                                         Hot Metal
  Door Man. |Closed     | Home                                          Door Close
  Close     |Prox       | Prox                                          Request
     B3        I:013      I:027                                           B3
-+---] [----+---]/[--------] [-----------------------------------------( )----
 |    131    |     03          01                                        138
 |Timer:
 |Hold Hot
 |Metal Door
 |Open
 |   T4:5
 +---]/[----+
       DN
ung 4:28
            |Timer:
 Status:    |Fast                                                       Output:
 Hot Metal  |Unload                                                     Hot Metal
 Door Close |Available                                                  Door Close
 Request    |                                                           Solenoid
     B3         T4:8                                                    O:021
----] [--------] [-----------------------------------------------------( )----
     138          DN                                                     07
ung 4:29
 Input:     |
 Inch       |Status:    |Input:                                         Output:
 Furnace Up |O.K. To    |Hot Metal                                      Crucible
 Pushbutton |Operate    |Door Open                                      Tilt Up
            |Doors      |Prox                                           Solenoid
   I:012         B3        I:013                                         O:021
----] [--------] [--------] [-----------------------------------------( )----
      07         119         02                                         16
```

ung 4:30

Input: Go Home PushButton	Input: Inch Furnace Up Pushbutton	Input: Inch Furnace Down Pushbutton	Input: Crucible Table Home Prox	Status: Crucible Tilt Auto. Down
I:012	I:012	I:012	I:027	B3
]/[04	]/[07	]/[11	]/[01	( ) 139

Status: Crucible Tilt Auto. Down
B3
]/[139

ung 4:31

Input: Inch Furnace Down Pushbutton	Output: Crucible Tilt Down Solenoid
I:012	O:025
]/[11	( ) 12

Status: Crucible Tilt Auto. Down
B3
]/[139

ung 4:32

Input: Crucible Tilter At 30 Degrees	Input: Crucible Table Home Prox	Output: Bail Arm Lock Solenoid
I:027	I:027	O:025
]/[00	]/[01	( ) 13

ung 4:33

Input: No.1 Tilt Cylinder Down	Input: No.2 Tilt Cylinder Down	Timer: Furnace Down	Timer: Furnace Down
I:012	I:012	T4:15	TON
] 00	] 01	]/[DN	TIMER ON DELAY +-(EN)
			Timer T4:15
			Time base 1.0 +-(DN)
			Preset 60
			Accum 6

ung 4:34

```
 Timer:                                                    Counter:
 Furnace                                                   Bleed Off
 Down                                                      Minute
   T4:15                                                   Counter
----] [-------------------------------------------------+CTU---------------+
      DN                                                |COUNT UP          +-(CU)
                                                        |Counter       C5:1|
                                                        |Preset          60+-(DN)
                                                        |Accum            28|
                                                        +------------------+
```

ung 4:35

```
  Counter:                                                                 Counter:
  Bleed Off                                                                Bleed Off
  Hour                                                                     Minute
  Counter                                                                  Counter
     C5:2                                                                     C5:1
-+---] [----+-------------------------------------------------------------(RES)---
 |      CU   |
 |Input:     |
 |No.1 Tilt  |
 |Cylinder   |
 |Down       |
 |   I:012   |
 +---]/[----+
 |      00   |
 |Input:     |
 |No.2 Tilt  |
 |Cylinder   |
 |Down       |
 |   I:012   |
 +---]/[----+
        01
```

ung 4:36

```
 Counter:                                                  Counter:
 Bleed Off                                                 Bleed Off
 Minute                                                    Hour
 Counter                                                   Counter
    C5:1                                                +CTU---------------+
----] [-------------------------------------------------+COUNT UP          +-(CU)
      DN                                                |Counter       C5:2|
                                                        |Preset           8+-(DN)
                                                        |Accum            6|
                                                        +------------------+
```

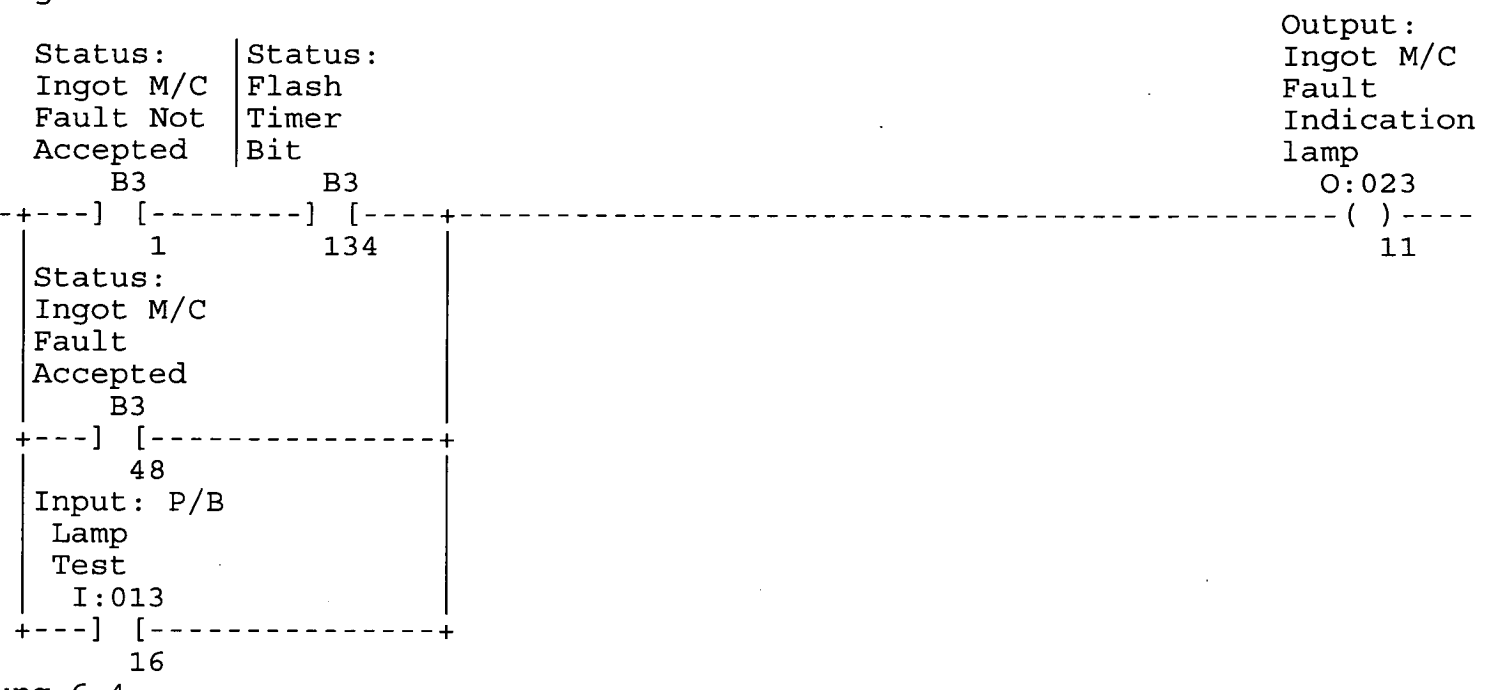
```
ung 4:37
  Input:                                                          Counter:
  No.1 Tilt                                                       Bleed Off
  Cylinder                                                        Hour
  Down                                                            Counter
    I:012                                                           C5:2
-+---]/[----+-------------------------------------------------------(RES)---
 |      00   |
 |Input:     |
 |No.2 Tilt  |
 |Cylinder   |
 |Down       |
 |  I:012    |
 +---]/[----+
       01
ung 4:38
  Counter:  |                                                     Status:
  Bleed Off |Output:    |                                         Air Bleed
  Hour      |Fast Tilt  |Timer:                                   Valve Aux.
  Counter   |Solenoid   |Bleed Off
    C5:2      O:021       T4:4                                      B3
-+---] [--------] [----+---]/[-----------------------------------------( )----
 |     DN          03  |     DN                                       130
 |Status:              |
 |Air Bleed            |
 |Valve Aux.           |
 |                     |
 |    B3               |
 +---] [---------------+
       130
ung 4:39
 Status:
 Air Bleed
 Valve Aux.
                                                    Bleed Off
                                                    Timer
    B3                                          +TON--------------+
----] [-----------------------------------------+TIMER ON DELAY   +-(EN)
    130                                         |Timer         T4:4|
                                                |Time base      1.0+-(DN)
                                                |Preset          60|
                                                |Accum            0|
                                                +-----------------+
ung 4:40
                                                                    Output:
 Status:                                                            Furnace
 Air Bleed                                                          Auto Air
 Valve Aux.                                                         Bleed
                                                                    Valve
    B3                                                                O:021
----] [-------------------------------------------------------------( )----
    130                                                               17
ung 4:41

-------------------------------[END OF FILE]-------------------------------
```

```
ung 5:0
                                                                  Output:
 Input:                                                           Metal door
 Main Door                                                        Open
 Closed                                                           Datataker
 Prox.                                                            Relay
   I:012                                                            O:025
----]/[-----------------------------------------------------------( )----
      15                                                              02
ung 5:1
 Input:                                                           Output:
 Hot Metal                                                        Hot Metal
 Door                                                             Door Open
 Closed                                                           Datataker
 Prox                                                             Relay
   I:013                                                            O:025
----]/[-----------------------------------------------------------( )----
      03                                                              03
ung 5:2
```

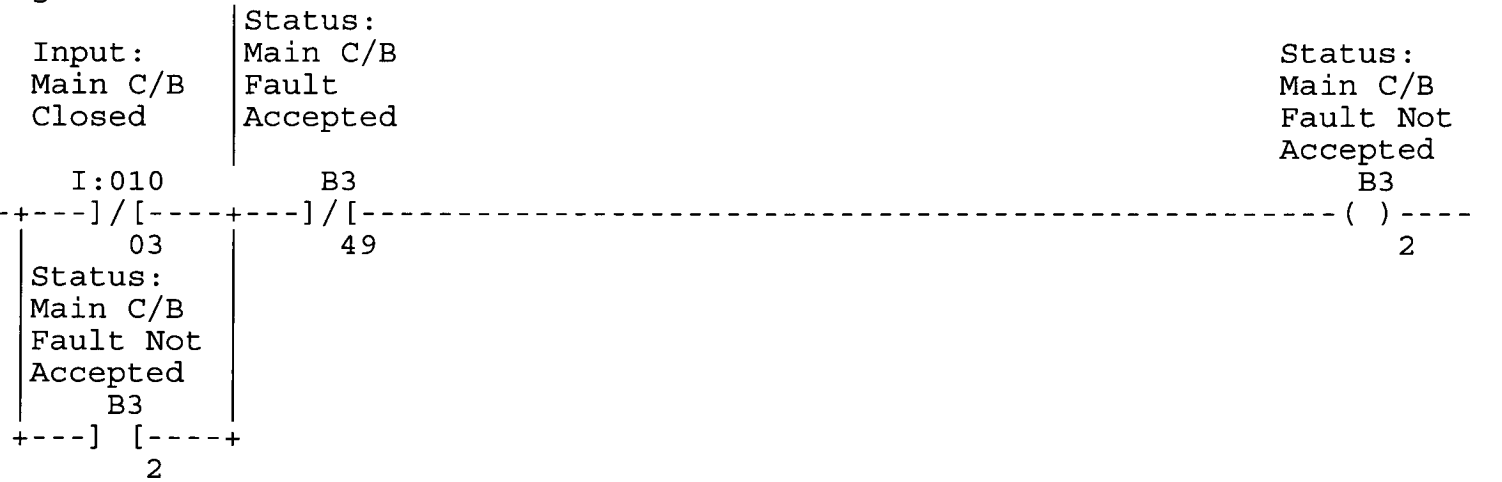
[END OF FILE]

```
ung 6:0
 Flash                                                          Flash
 Timer                                                          Timer
    T4:3                                                    +TON---------------+
----]/[-----------------------------------------------------+TIMER ON DELAY    +-(EN)
      DN                                                    |Timer         T4:3|
                                                            |Time base     0.01+-(DN)
                                                            |Preset          80|
                                                            |Accum           36|
                                                            +------------------+

ung 6:1
  Input:      |Status:                                                    Status:
  Ingot       |Ingot M/C                                                  Ingot M/C
  Machine     |Fault                                                      Fault Not
  O.K.        |Accepted                                                   Accepted
    I:010          B3                                                        B3
-+---]/[----+---]/[-------------------------------------------------------( )----
 |      02  |      48                                                       1
 |Status:   |
 |Ingot M/C |
 |Fault Not |
 |Accepted  |
 |     B3   |
 +---]  [----+
        1

ung 6:2
             |Input:      |Input:
  Status:    |Alarm       |Alarm                                         Status:
  Ingot M/C  |Accept      |Reset                                         Ingot M/C
  Fault Not  |Pushbutton  |Pushbutton                                    Fault
  Accepted   |            |                                              Accepted
      B3         I:013        I:013                                         B3
-+---]  [---------]  [----+---]/[-----------------------------------------( )----
 |       1           14   |     15                                         48
 |Status:                 |
 |Ingot M/C               |
 |Fault                   |
 |Accepted                |
 |     B3                 |
 +---]  [-----------------+
        48
```

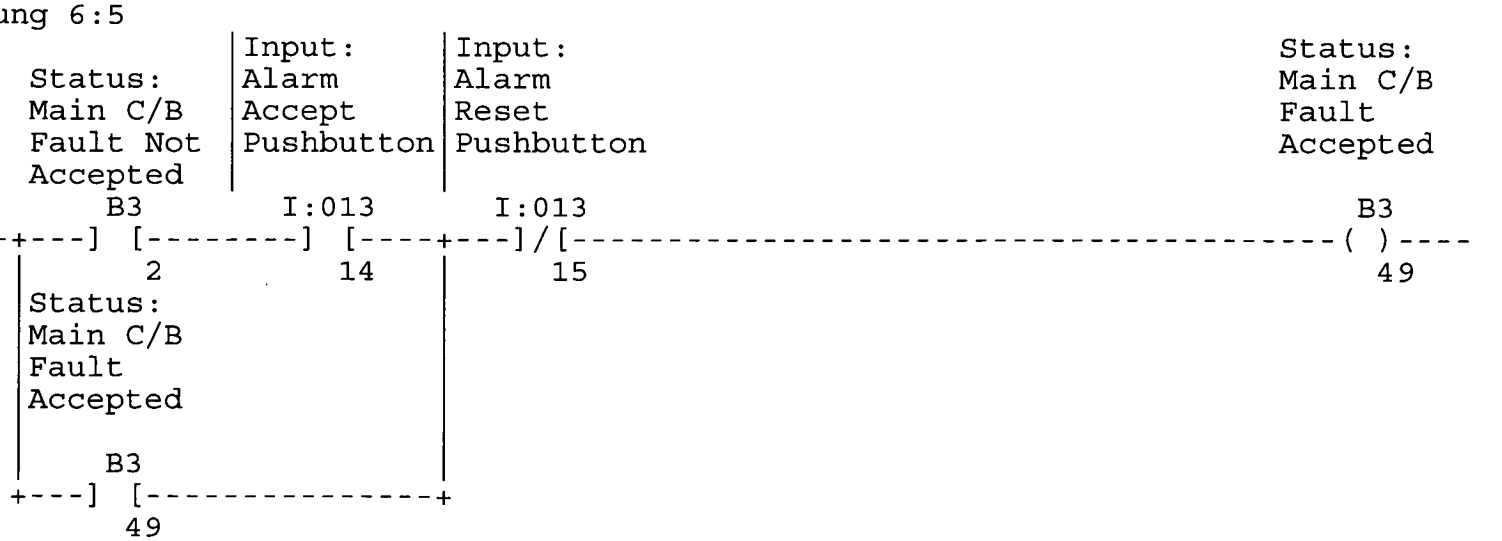
ung 6:3



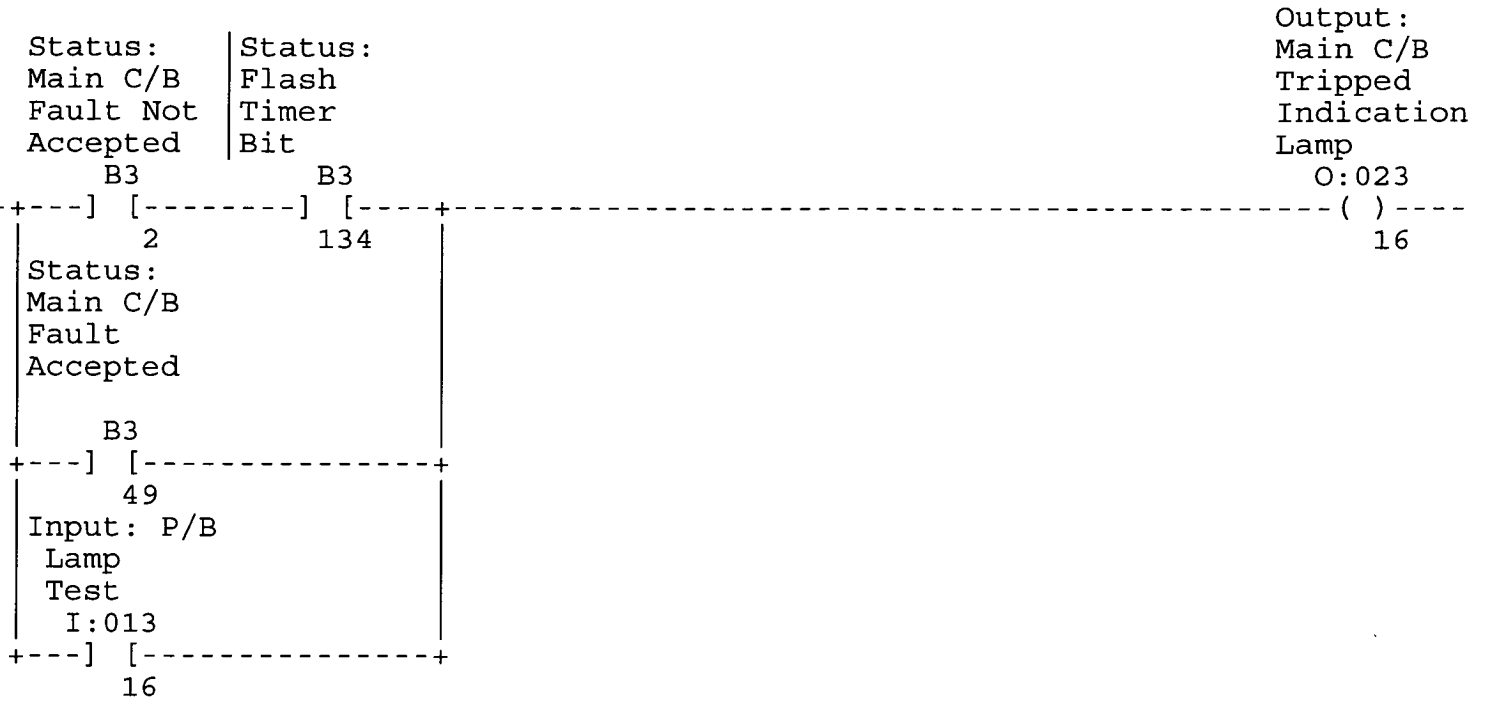
ung 6:4



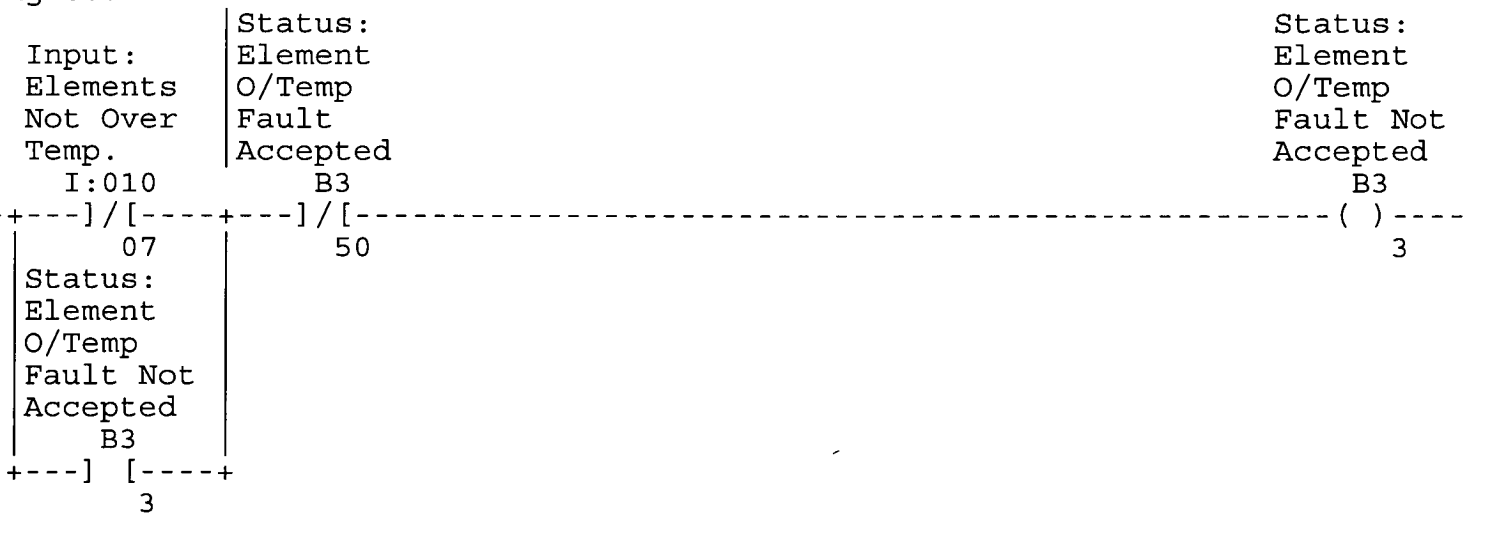
ung 6:5



ung 6:6

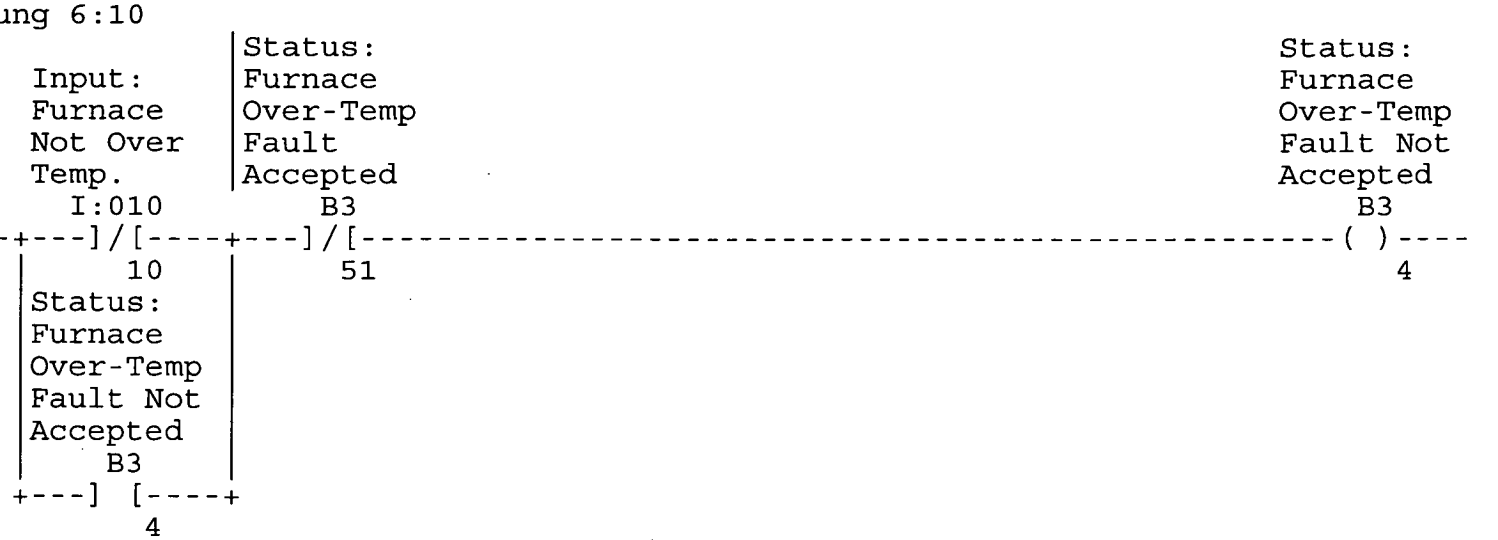

Status:
Main C/B
Fault Not
Accepted
B3
2
Status:
Flash
Timer
Bit
B3
134
Output:
Main C/B
Tripped
Indication
Lamp
O:023
16
Status:
Main C/B
Fault
Accepted
B3
49
Input: P/B
Lamp
Test
I:013
16

ung 6:7

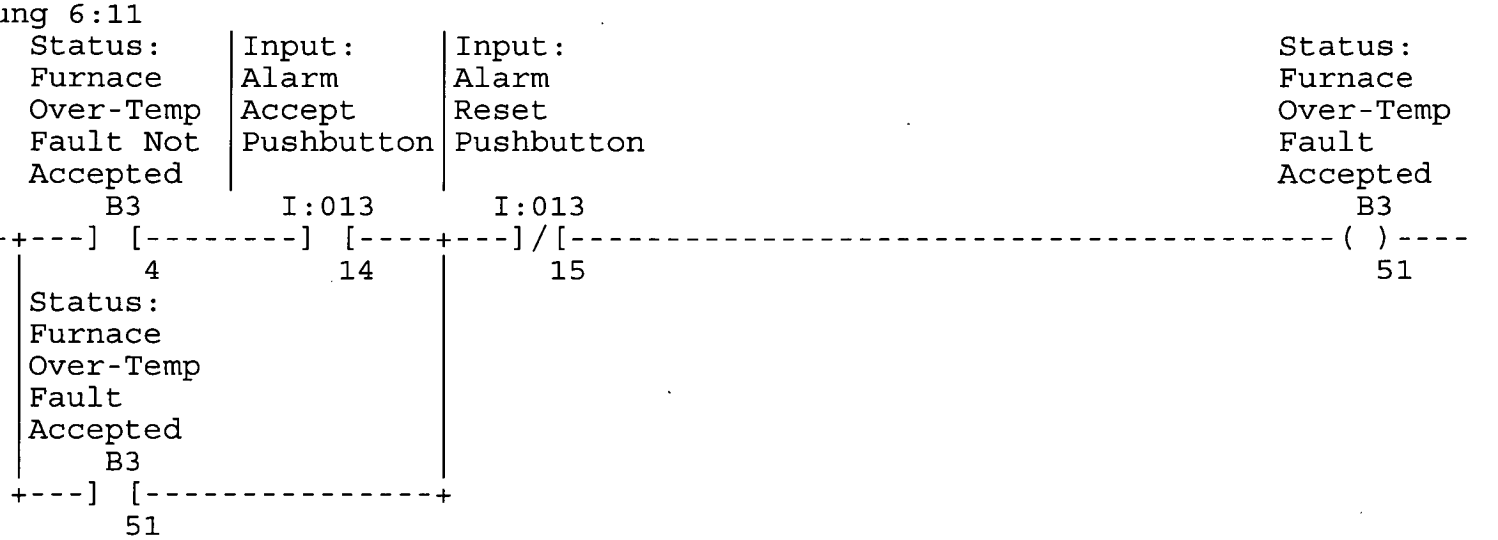

Input:
Elements
Not Over
Temp.
I:010
07
Status:
Element
O/Temp
Fault
Accepted
B3
50
Status:
Element
O/Temp
Fault Not
Accepted
B3
3
Status:
Element
O/Temp
Fault Not
Accepted
B3
3

```
ung 6:8
  Status:    |Input:     |Input:                                                    Status:
  Element    |Alarm      |Alarm                                                     Element
  O/Temp     |Accept     |Reset                                                     O/Temp
  Fault Not  |Pushbutton |Pushbutton                                                Fault
  Accepted   |           |                                                          Accepted
       B3          I:013        I:013                                                  B3
-+---] [--------] [----+---]/[-----------------------------------------( )----
 |       3           14 |       15                                                   50
 |Status:               |
 |Element               |
 |O/Temp                |
 |Fault                 |
 |Accepted              |
 |    B3                |
 +---] [----------------+
        50
ung 6:9
  Status:    |                                                                     Output:
  Element    |Status:                                                              Element
  O/Temp     |Flash                                                                O/Temp
  Fault Not  |Timer                                                                Indication
  Accepted   |Bit
       B3           B3                                                              O:023
-+---] [--------] [----+-----------------------------------------------( )----
 |       3         134 |                                                            12
 |Status:              |
 |Element              |
 |O/Temp               |
 |Fault                |
 |Accepted             |
 |    B3               |
 +---] [---------------+
 |      50             |
 |Input: P/B           |
 | Lamp                |
 | Test                |
 |  I:013              |
 +---] [---------------+
        16
```

ung 6:10



ung 6:11



ung 6:12

```
  Status:  |                                                                  Output:
  Furnace  |Status:                                                           Furnace
  Over-Temp|Flash                                                            Over-Temp
  Fault Not|Timer                                                            Indication
  Accepted |Bit                                                              Lamp
      B3          B3                                                           O:023
-+---] [--------] [----+-------------------------------------------------( )----
 |       4         134 |                                                     13
 |Status:              |
 |Furnace              |
 |Over-Temp            |
 |Fault                |
 |Accepted             |
 |    B3               |
 +---] [---------------+
 |      51             |
 |Input: P/B           |
 | Lamp                |
 | Test                |
 |  I:013              |
 +---] [---------------+
       16
```

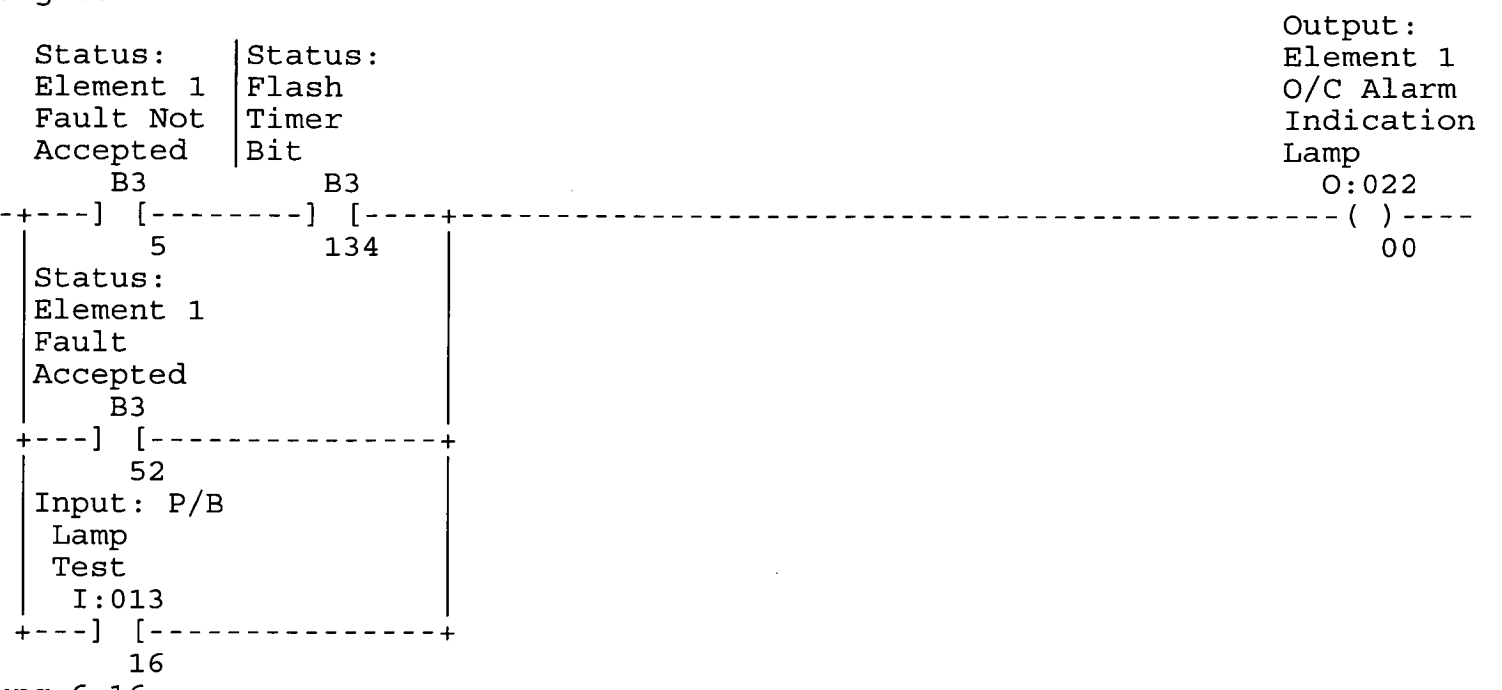
ung 6:13

```
  Input:   |Status:                                                           Status:
  Element  |Element 1                                                        Element 1
  No.1, not|Fault                                                            Fault Not
  Tripped  |Accepted                                                         Accepted
    I:010        B3                                                             B3
-+---]/[----+---]/[-------------------------------------------------( )----
 |      11  |     52                                                          5
 |Status:   |
 |Element 1 |
 |Fault Not |
 |Accepted  |
 |    B3    |
 +---] [----+
       5
```

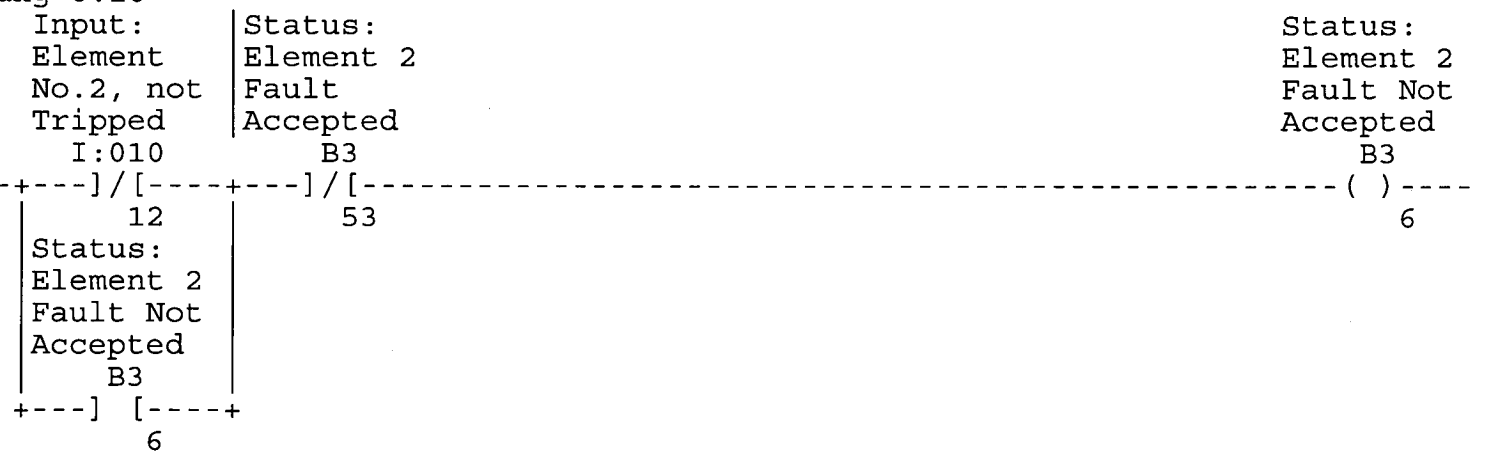
ung 6:14

```
           |Input:    |Input:
  Status:  |Alarm     |Alarm                                                  Status:
  Element 1|Accept    |Reset                                                  Element 1
  Fault Not|Pushbutton|Pushbutton                                             Fault
  Accepted |          |                                                       Accepted
      B3       I:013      I:013                                                  B3
-+---] [--------] [----+---]/[-------------------------------------------( )----
 |       5         14  |     15                                                52
 |Status:              |
 |Element 1            |
 |Fault                |
 |Accepted             |
 |    B3               |
 +---] [---------------+
       52
```

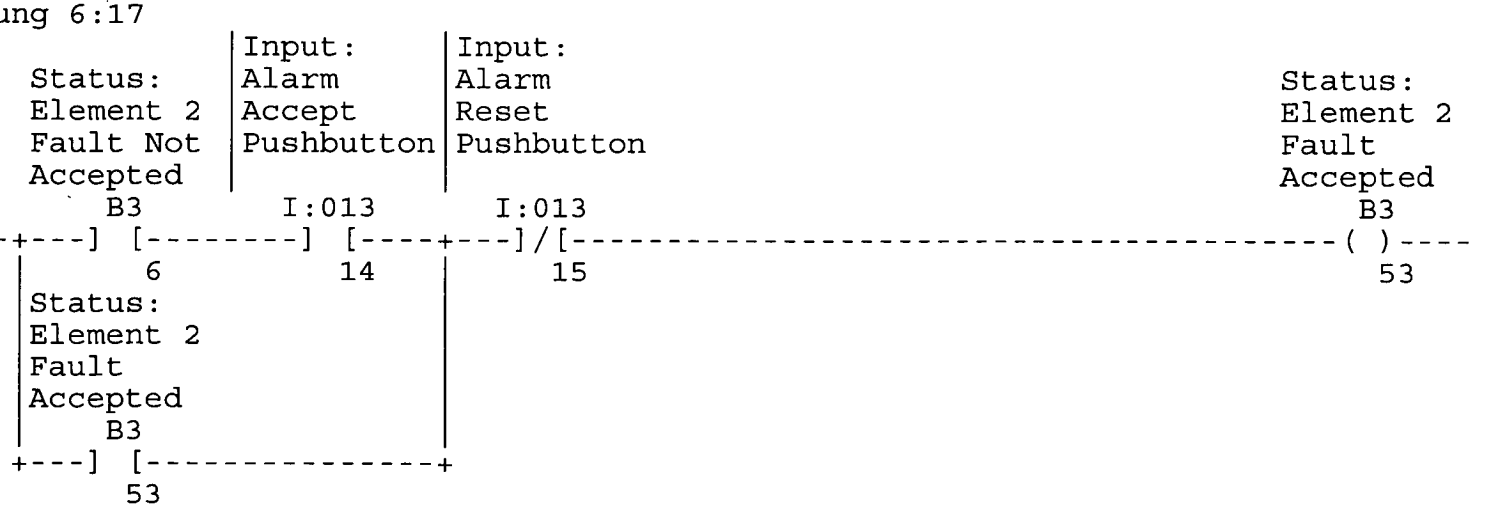
ung 6:15



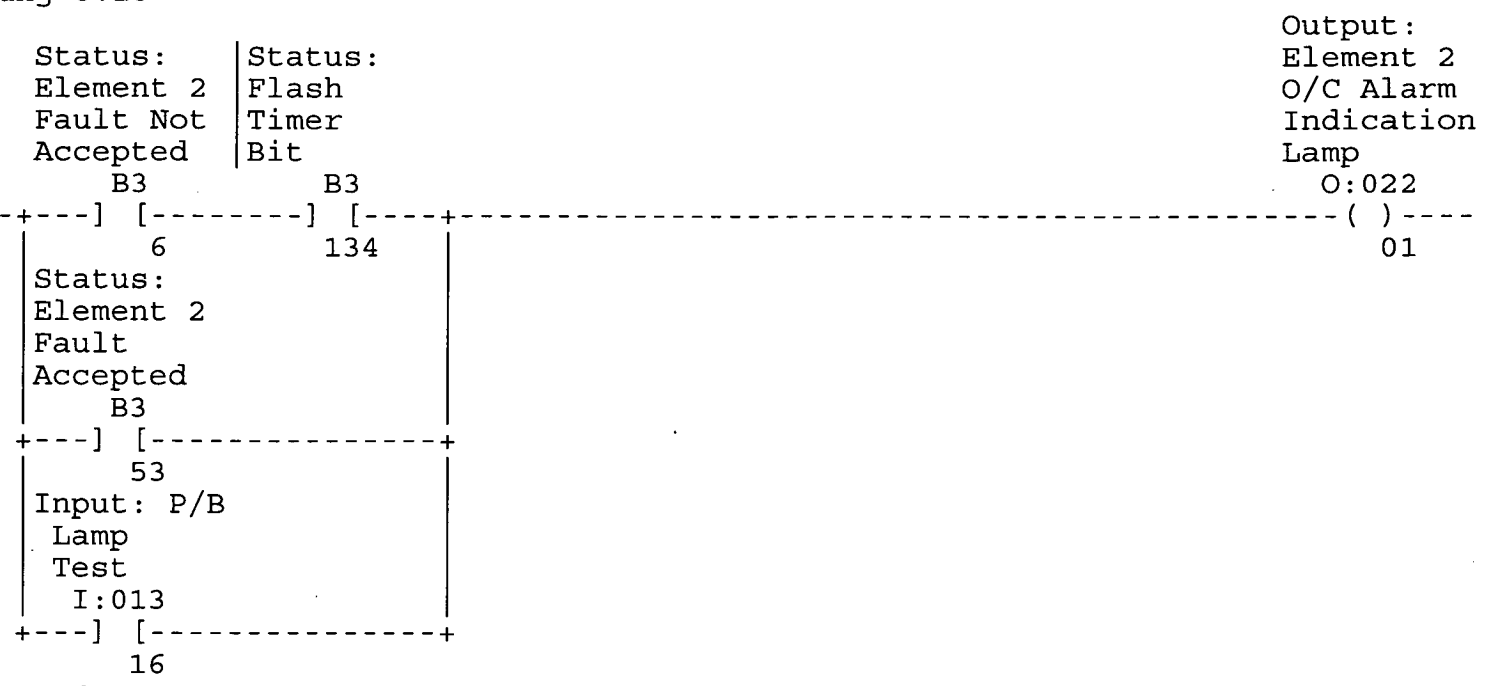
ung 6:16



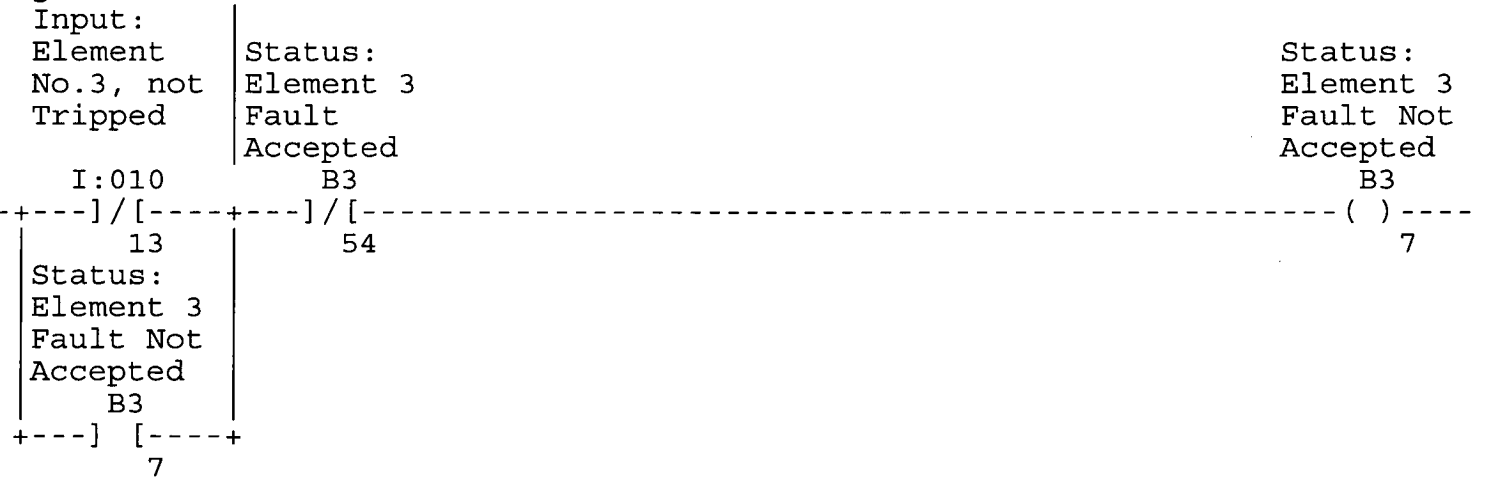
ung 6:17



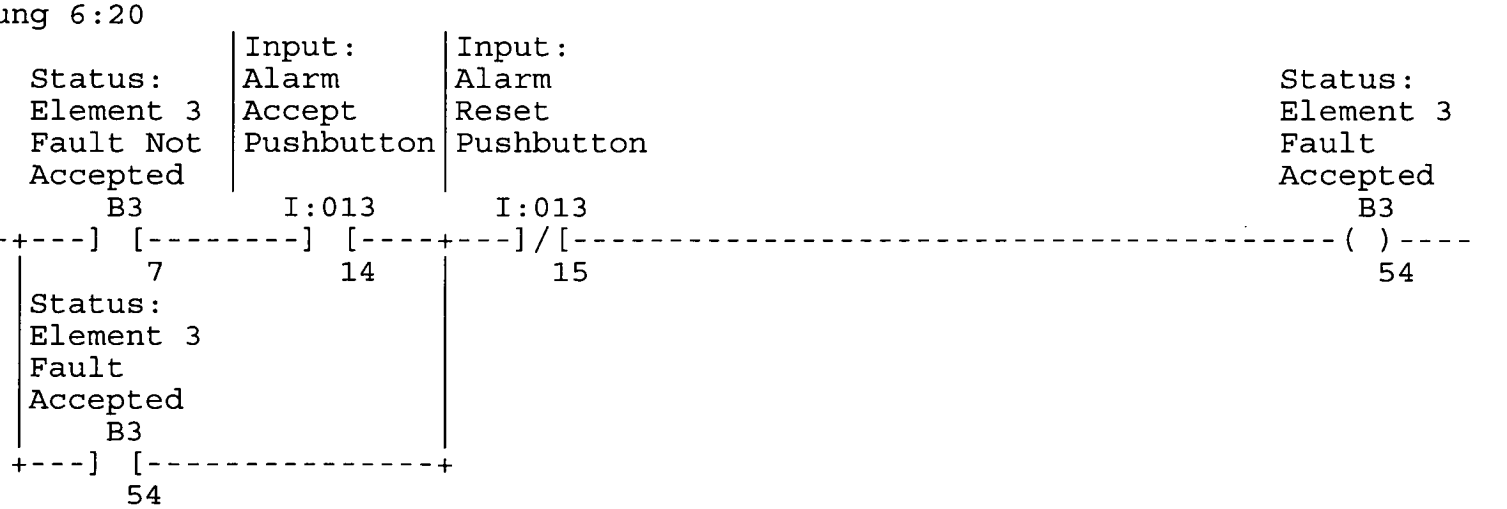
ung 6:18



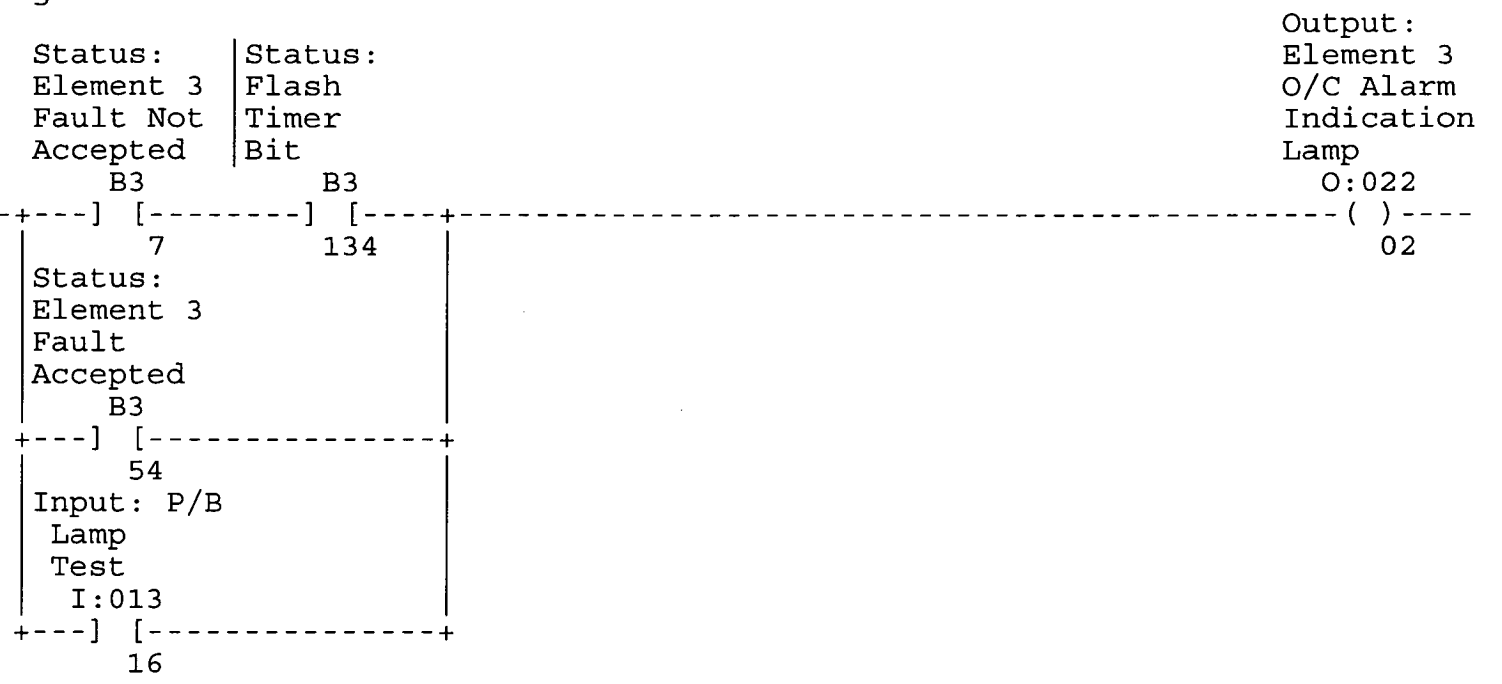
ung 6:19



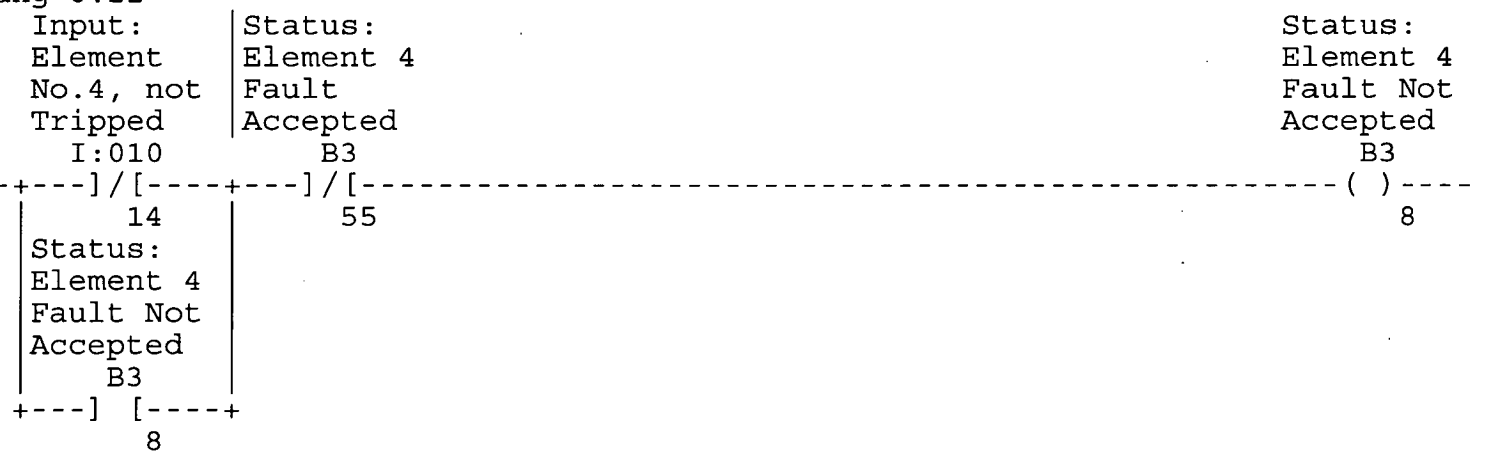
ung 6:20



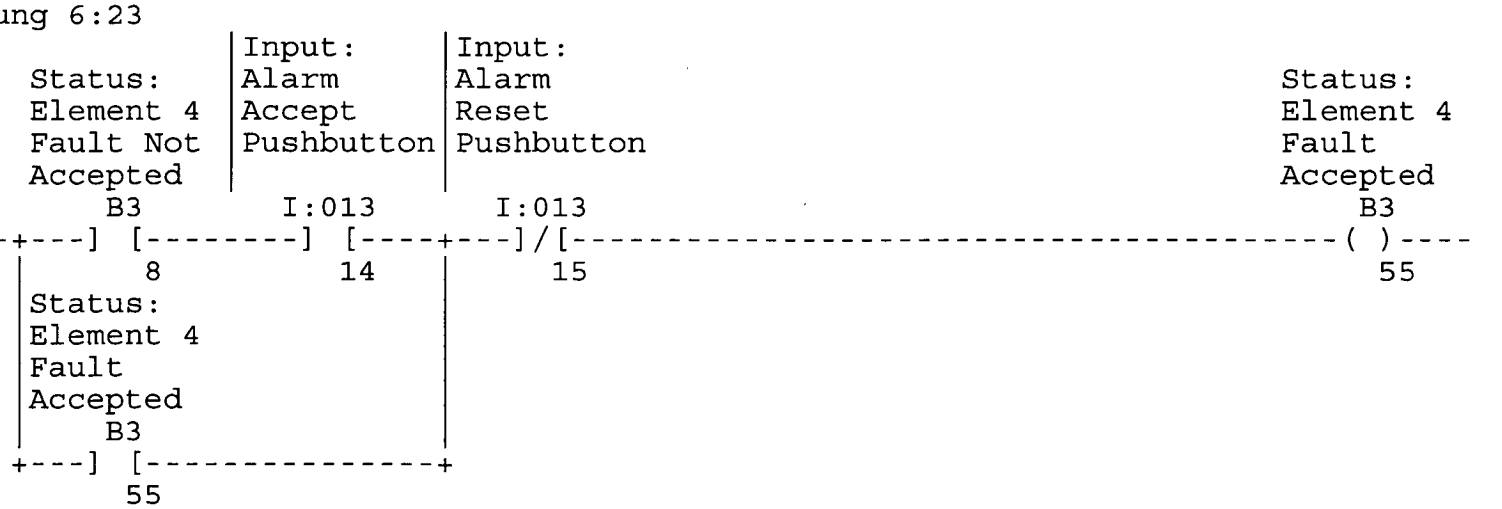
ung 6:21



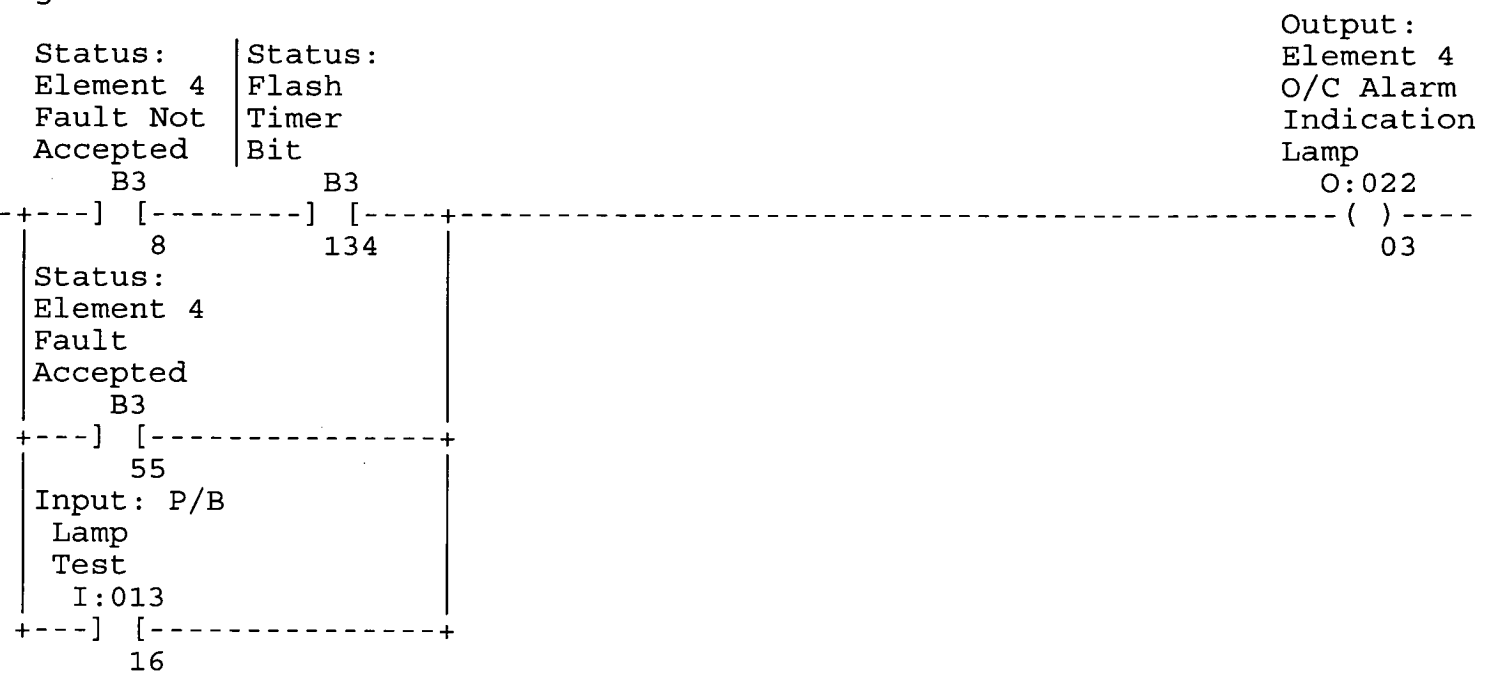
ung 6:22



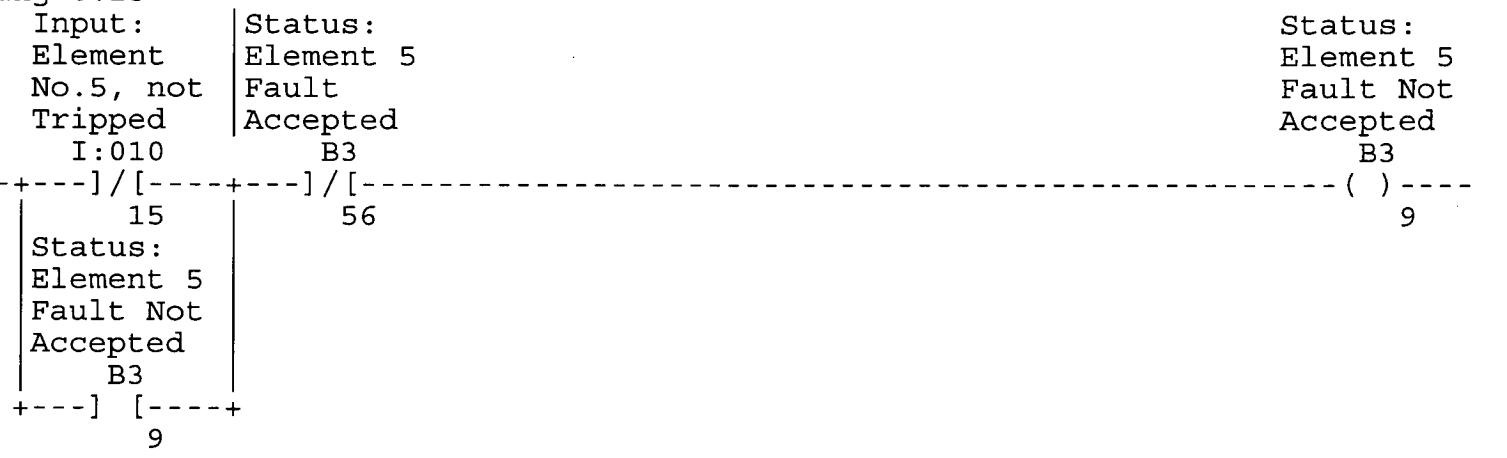
ung 6:23



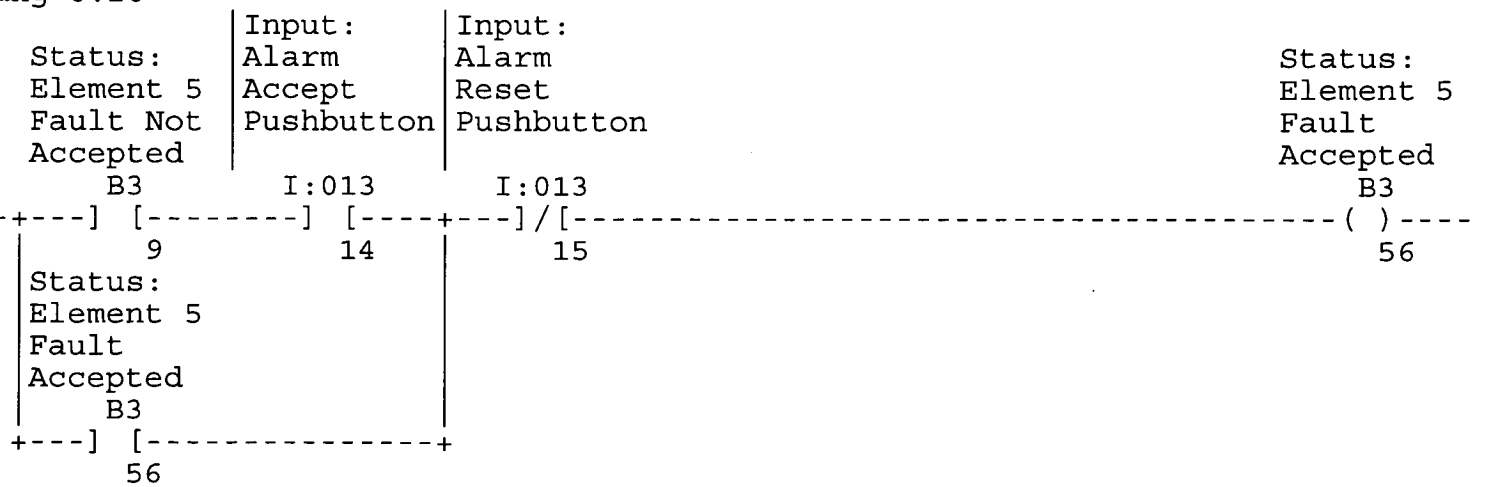
ung 6:24



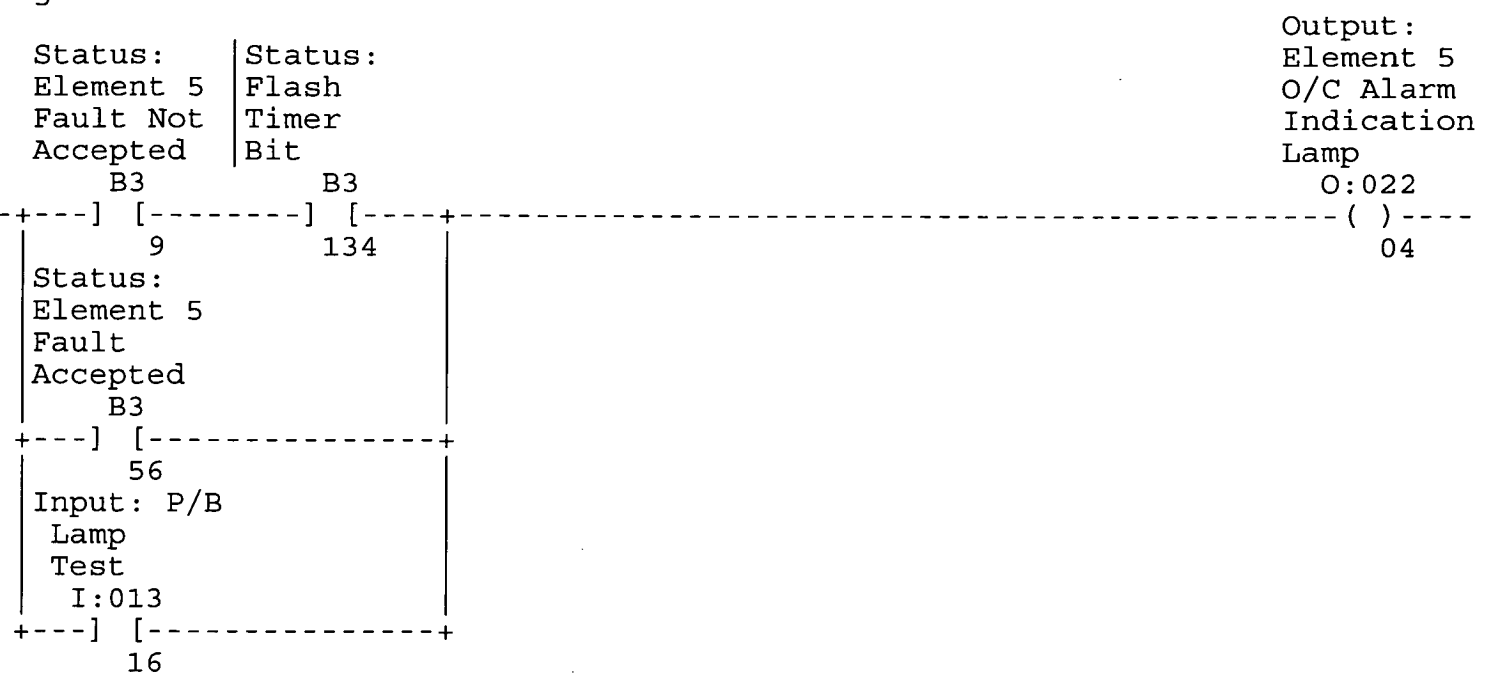
ung 6:25



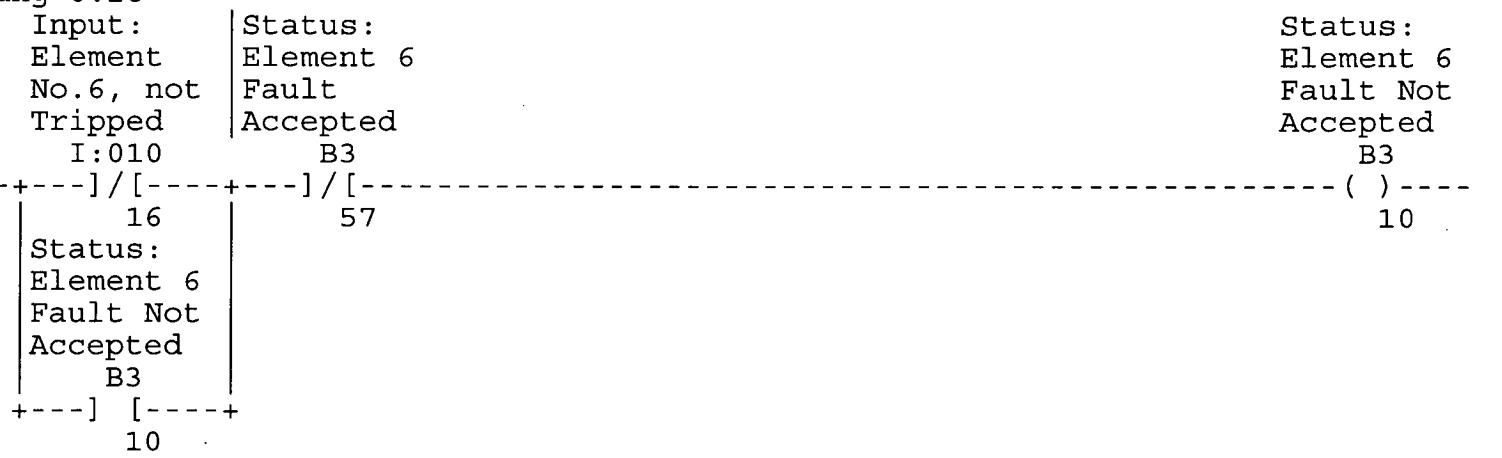
ung 6:26



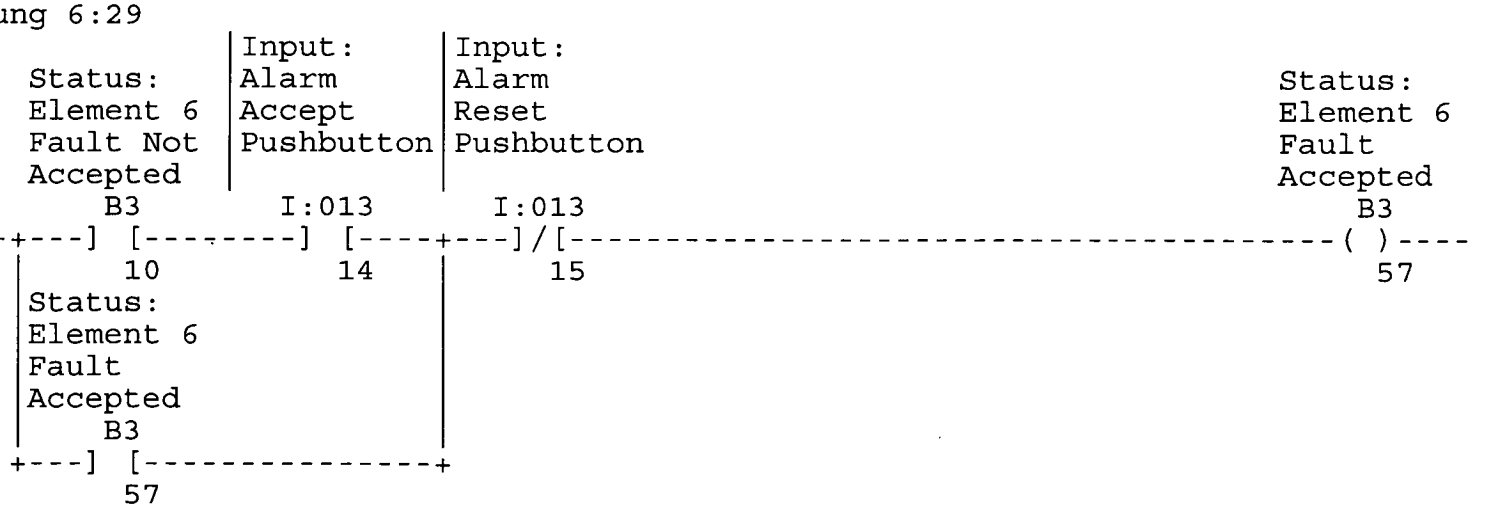
ung 6:27



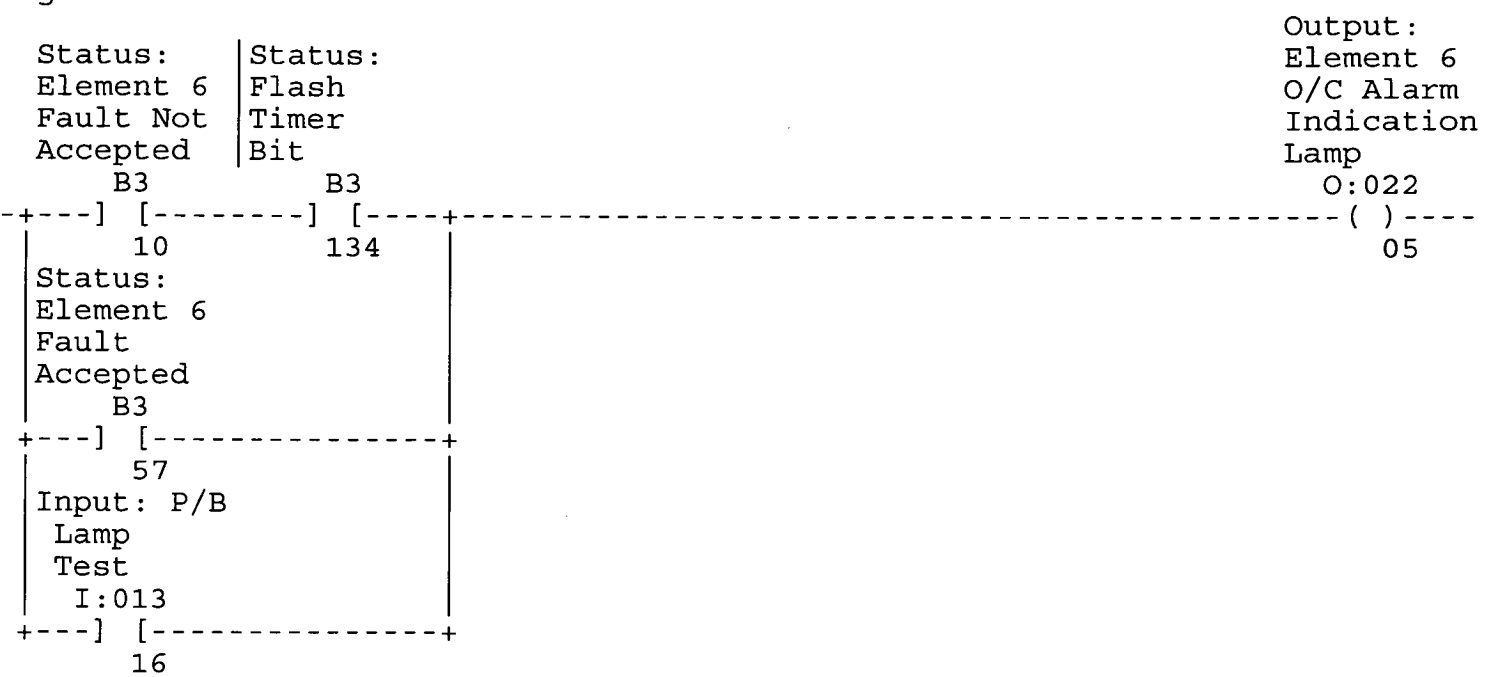
ung 6:28



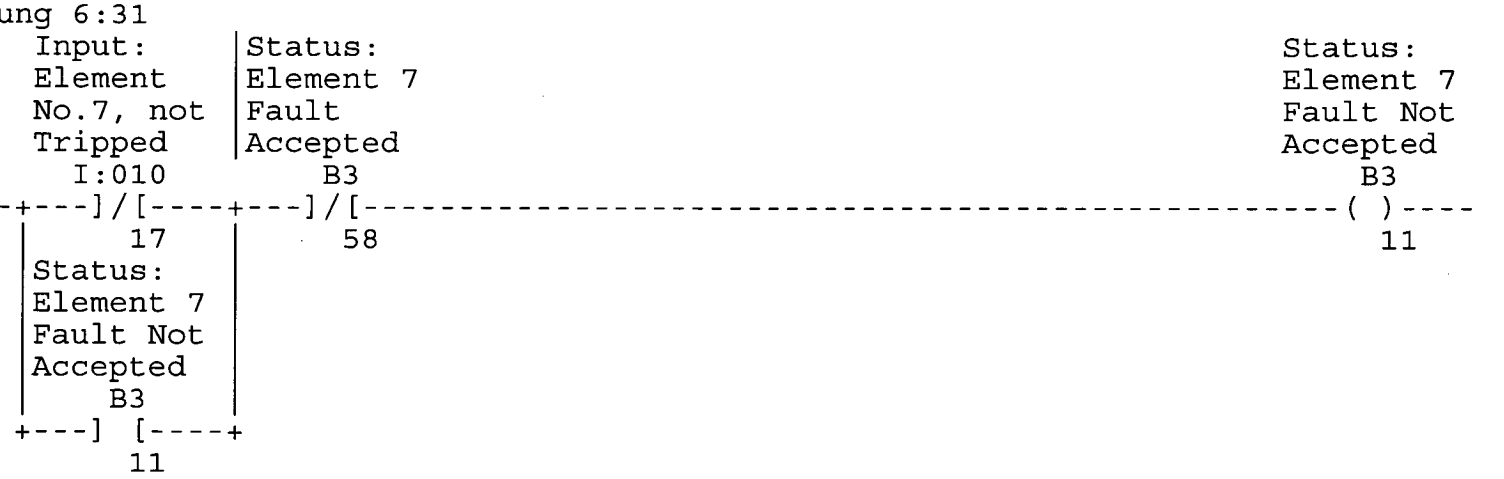
ung 6:29



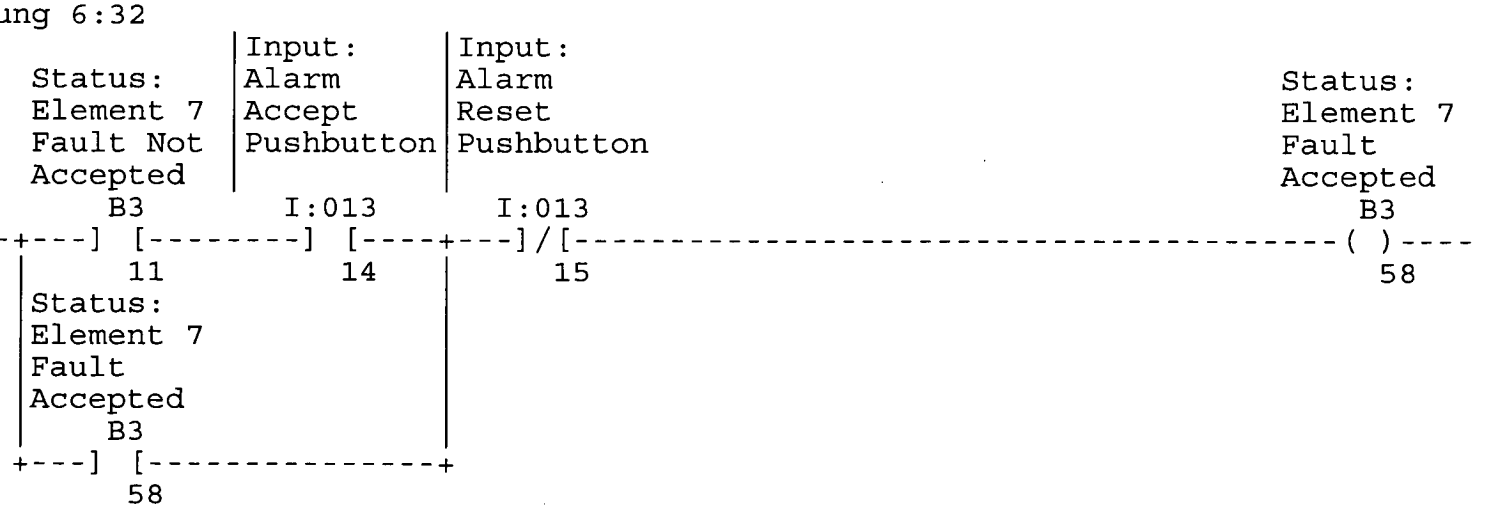
ung 6:30



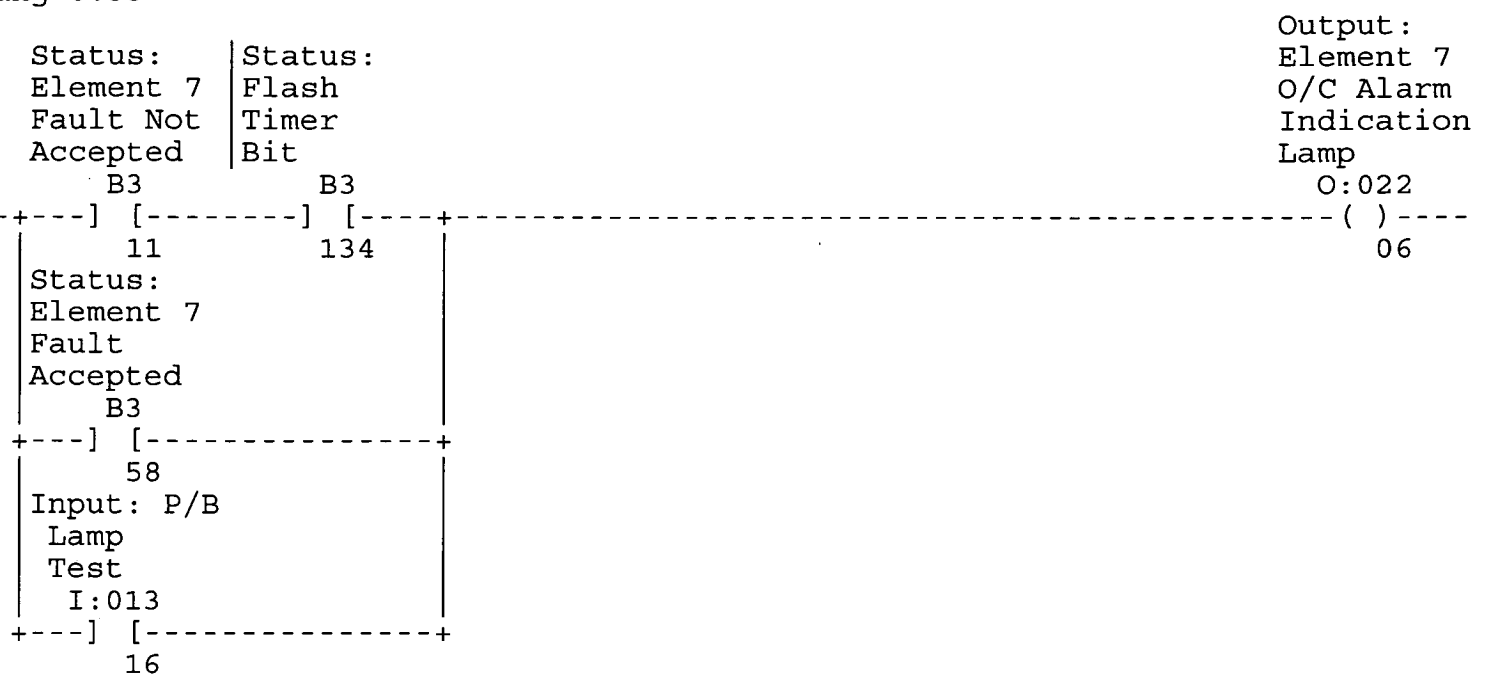
ung 6:31



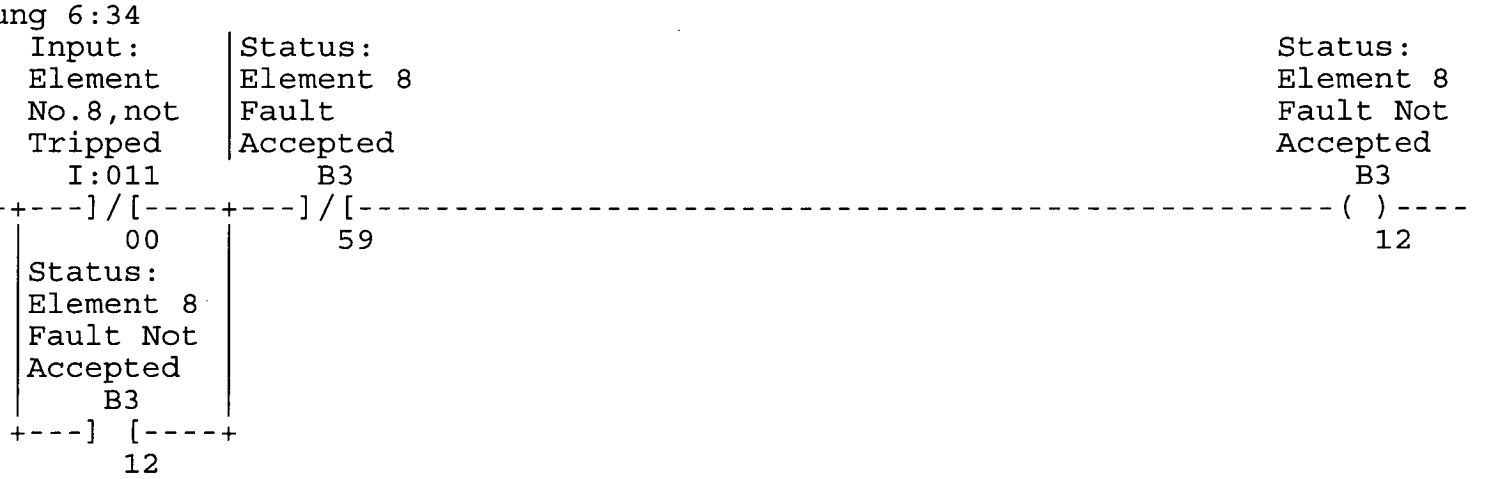
ung 6:32



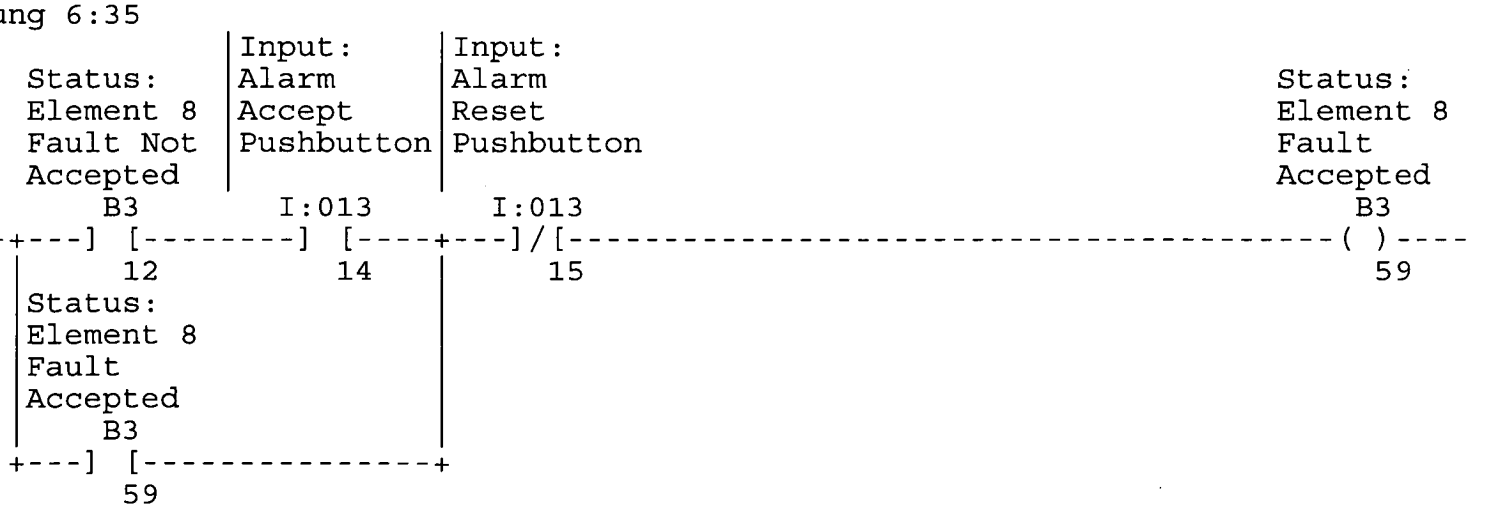
ung 6:33



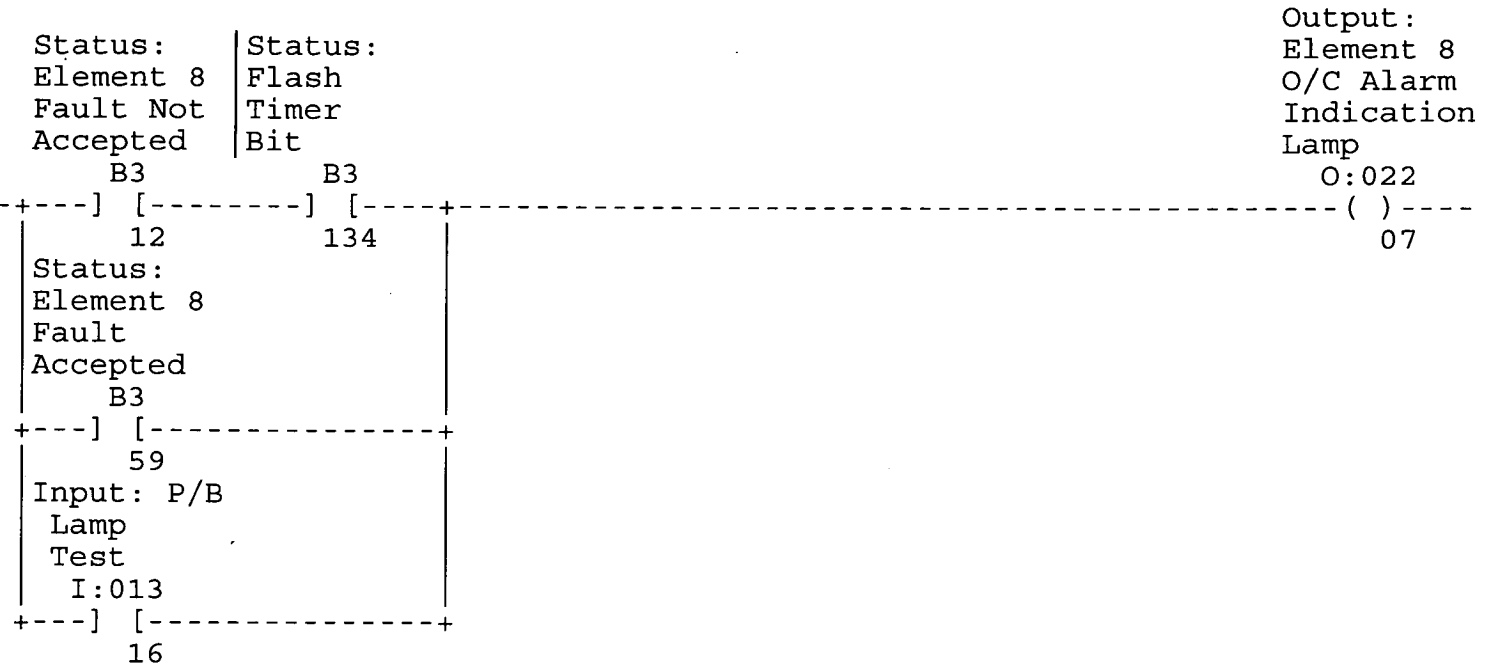
ung 6:34



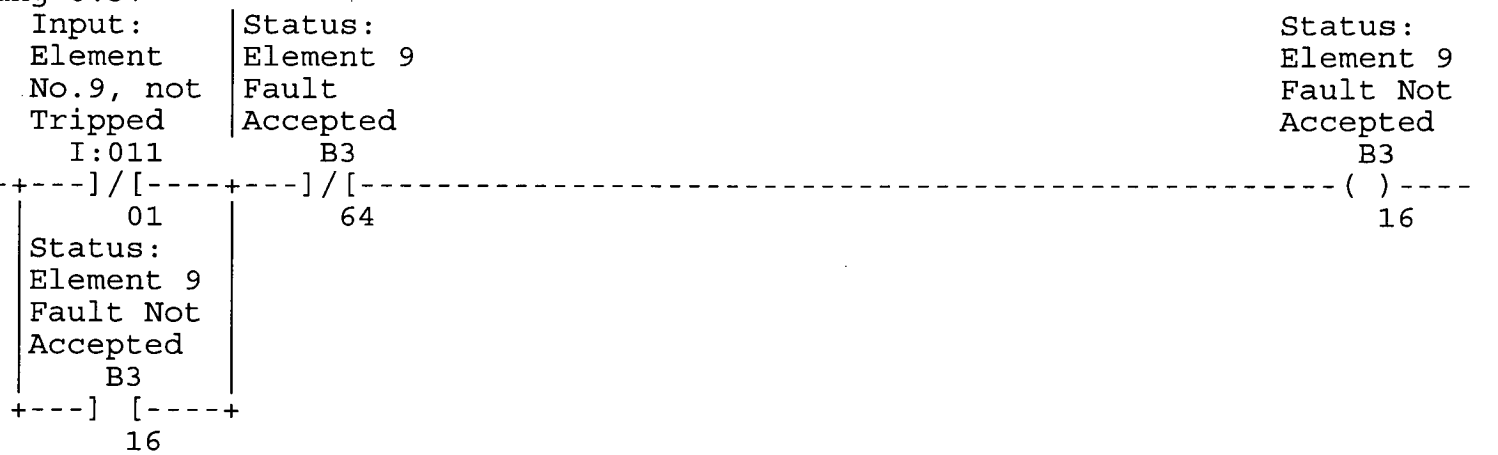
ung 6:35



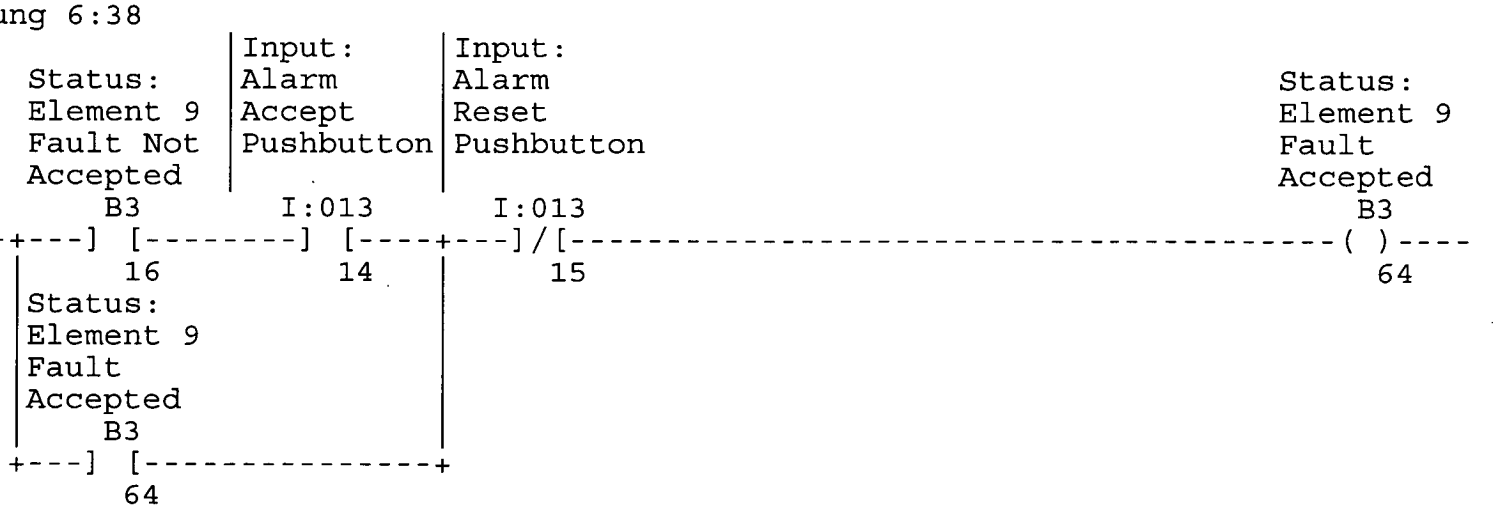
ung 6:36



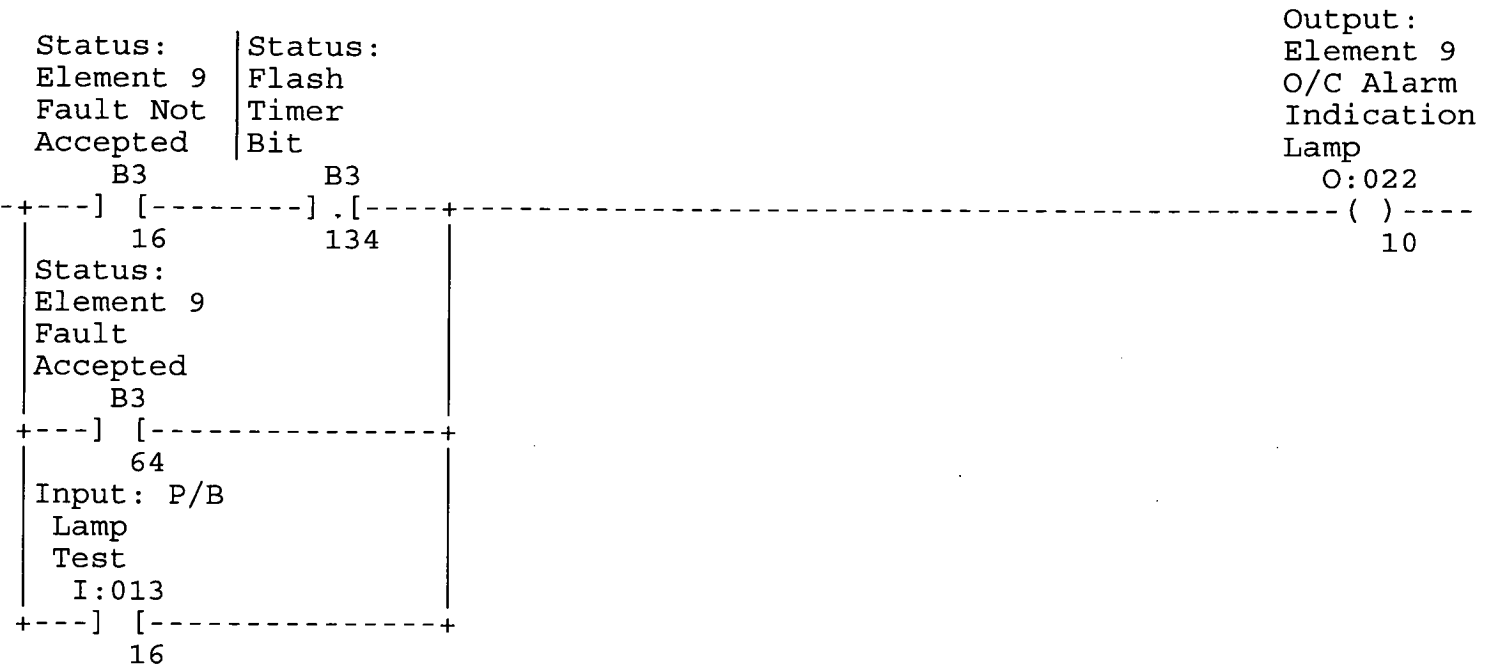
ung 6:37



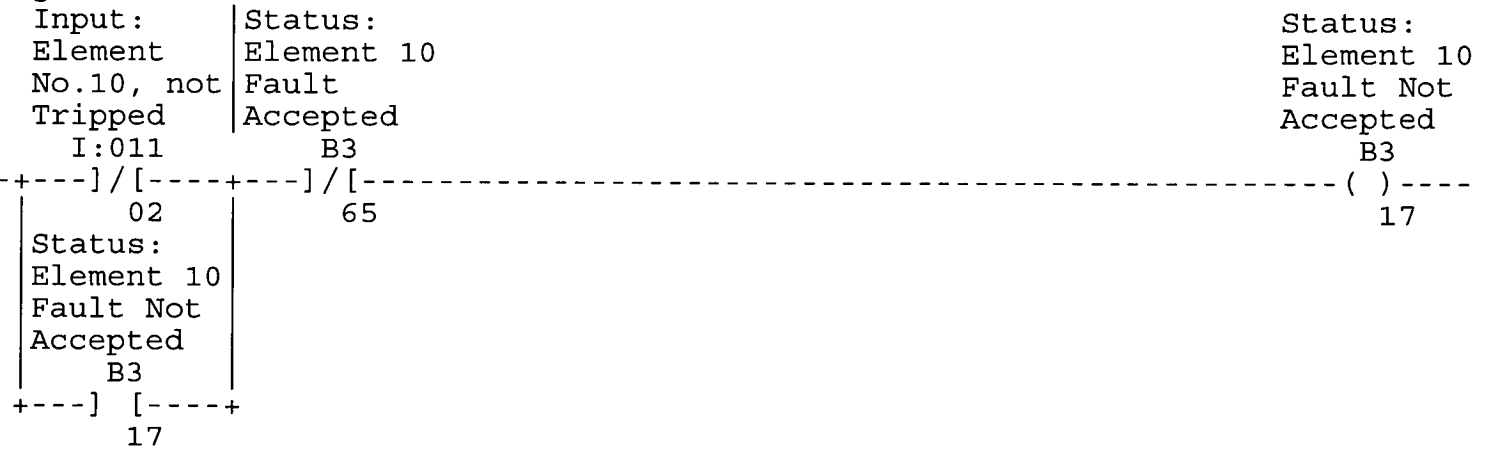
ung 6:38



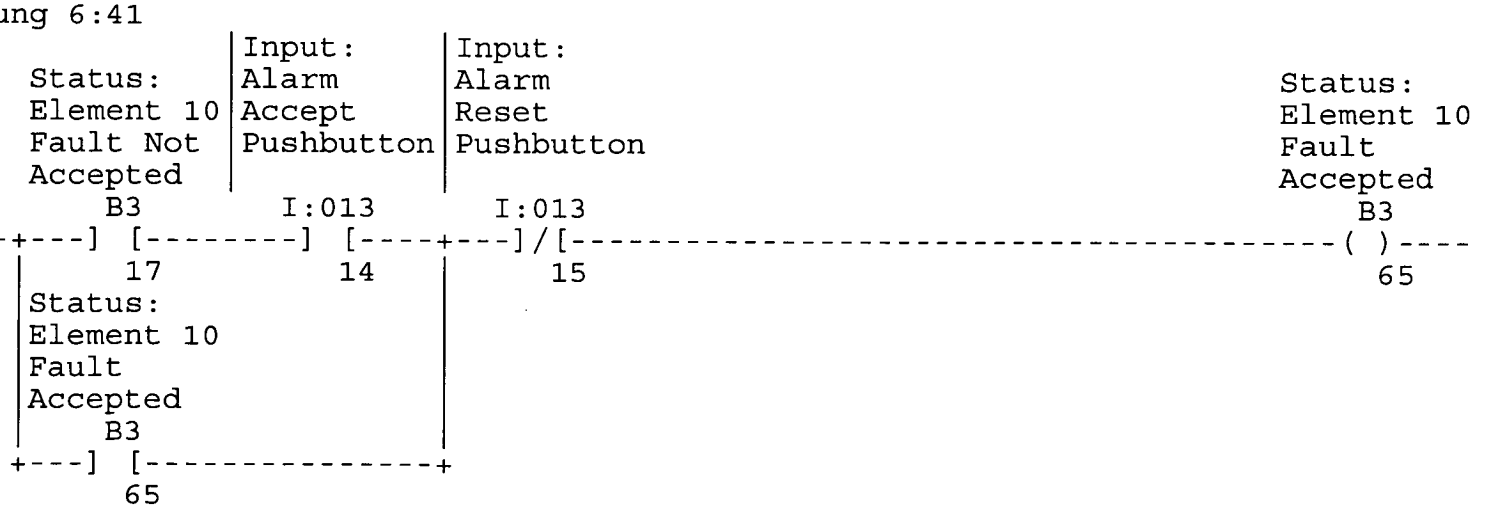
ung 6:39



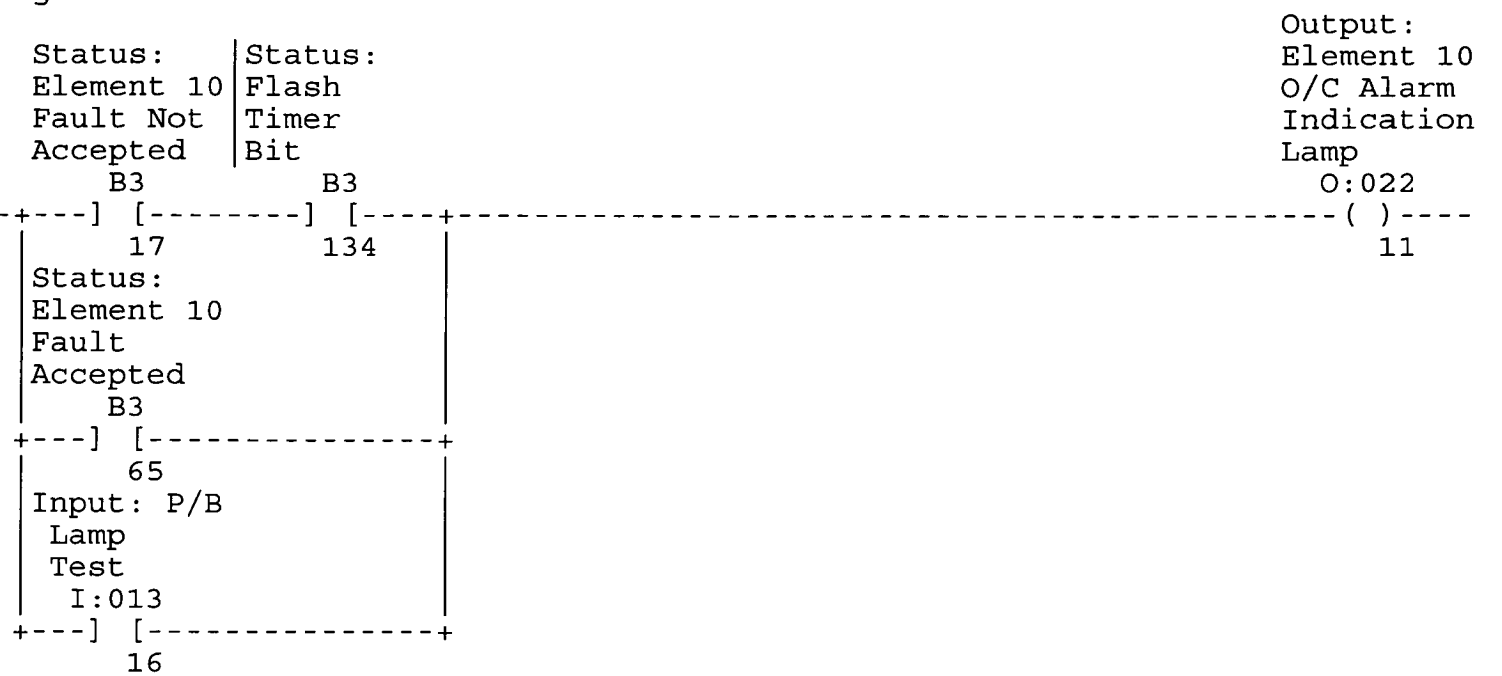
ung 6:40



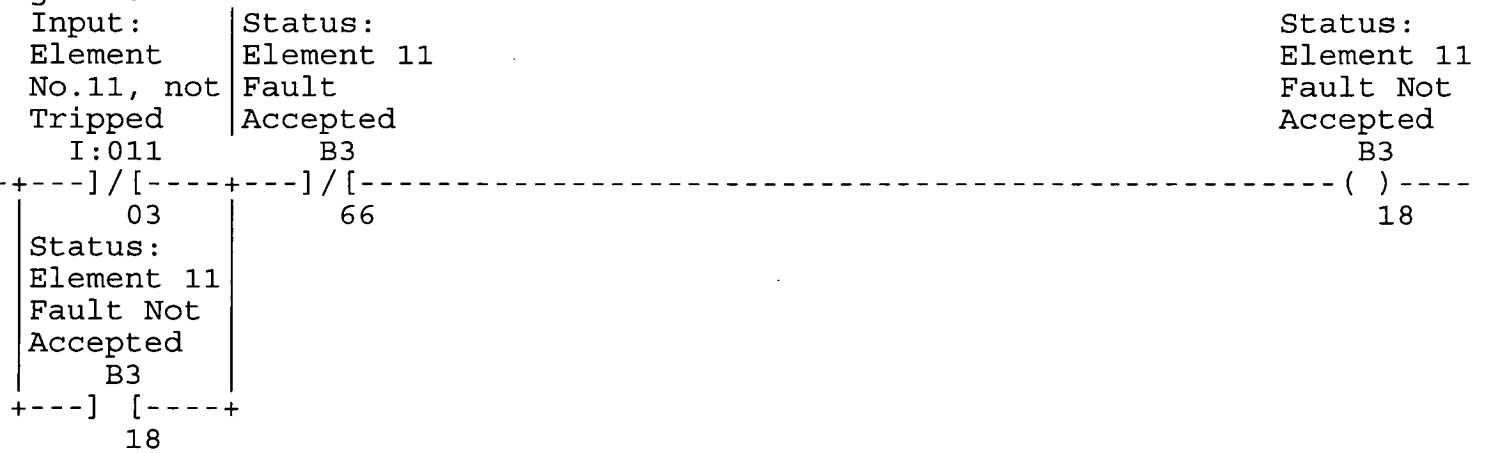
ung 6:41



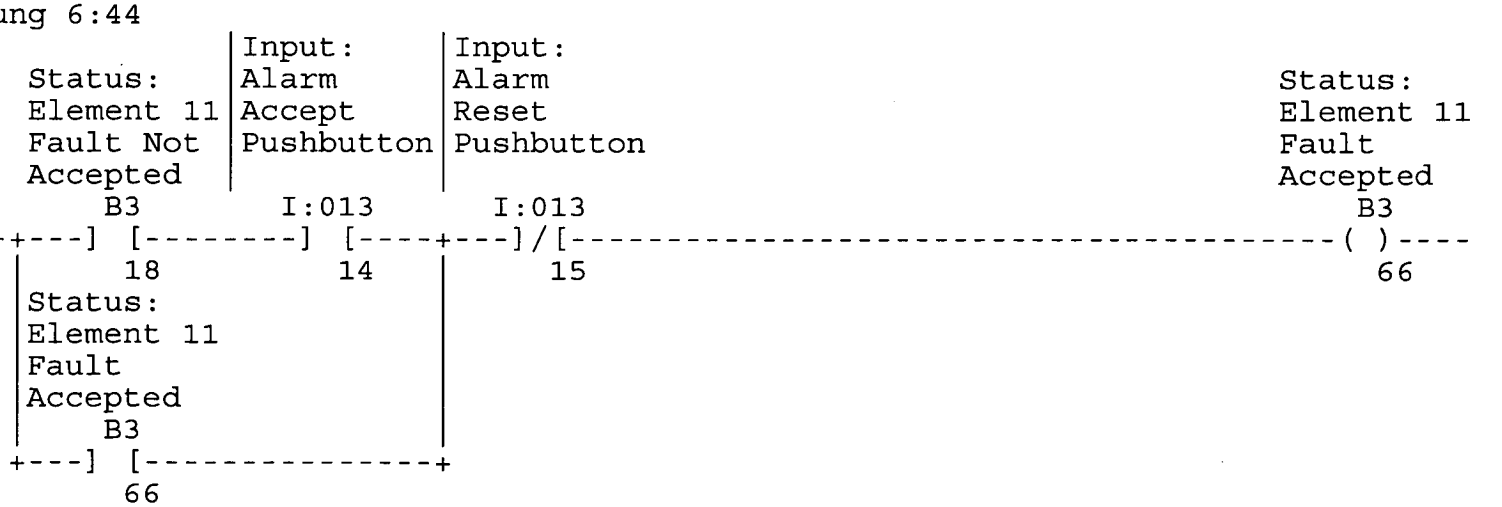
ung 6:42



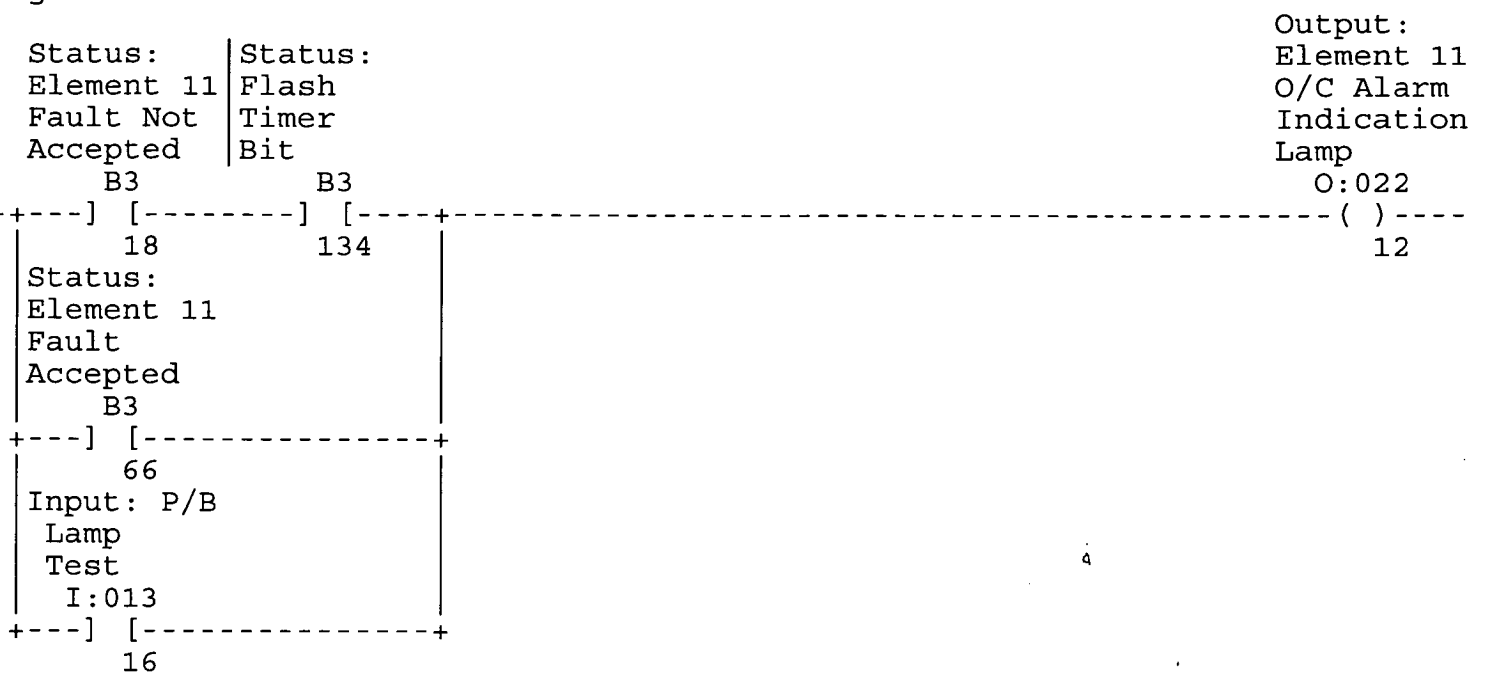
ung 6:43



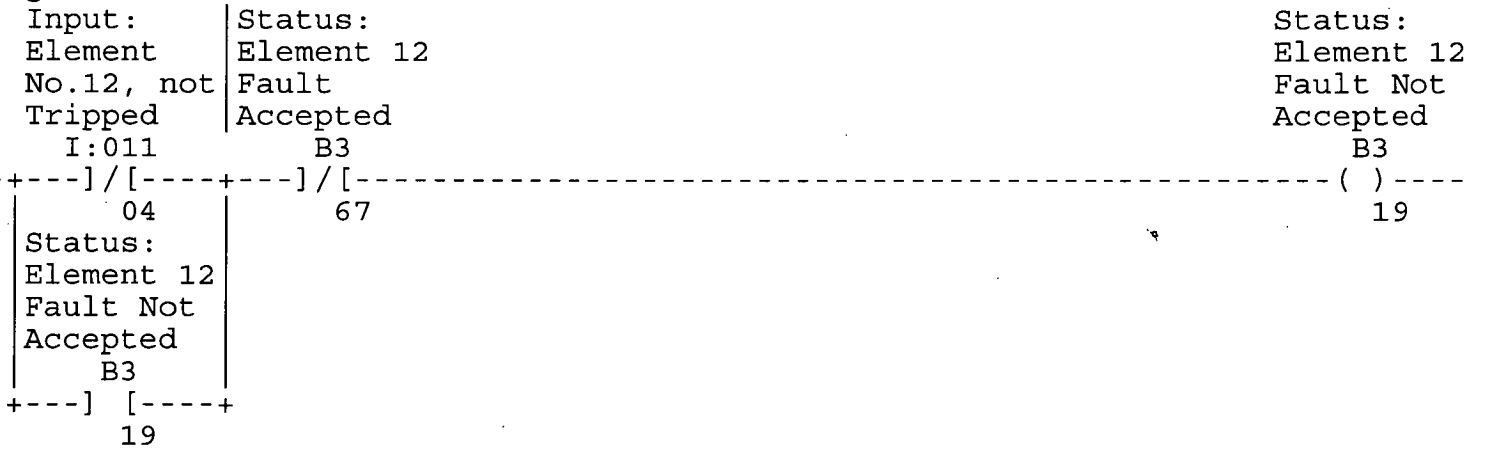
ung 6:44



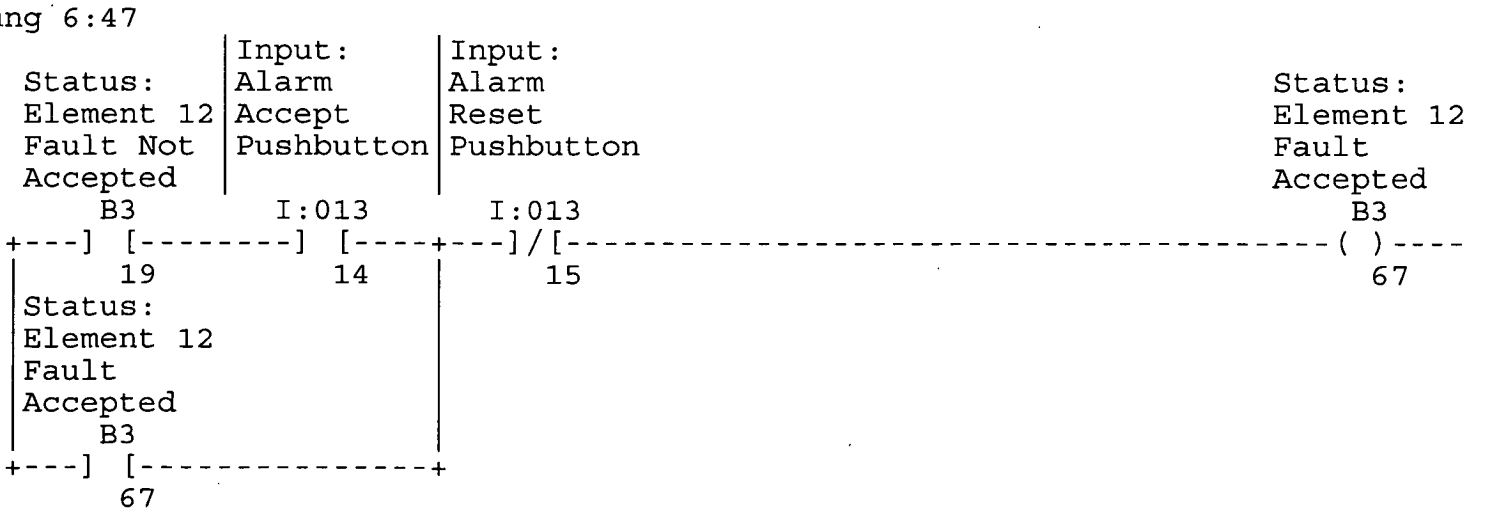
ung 6:45



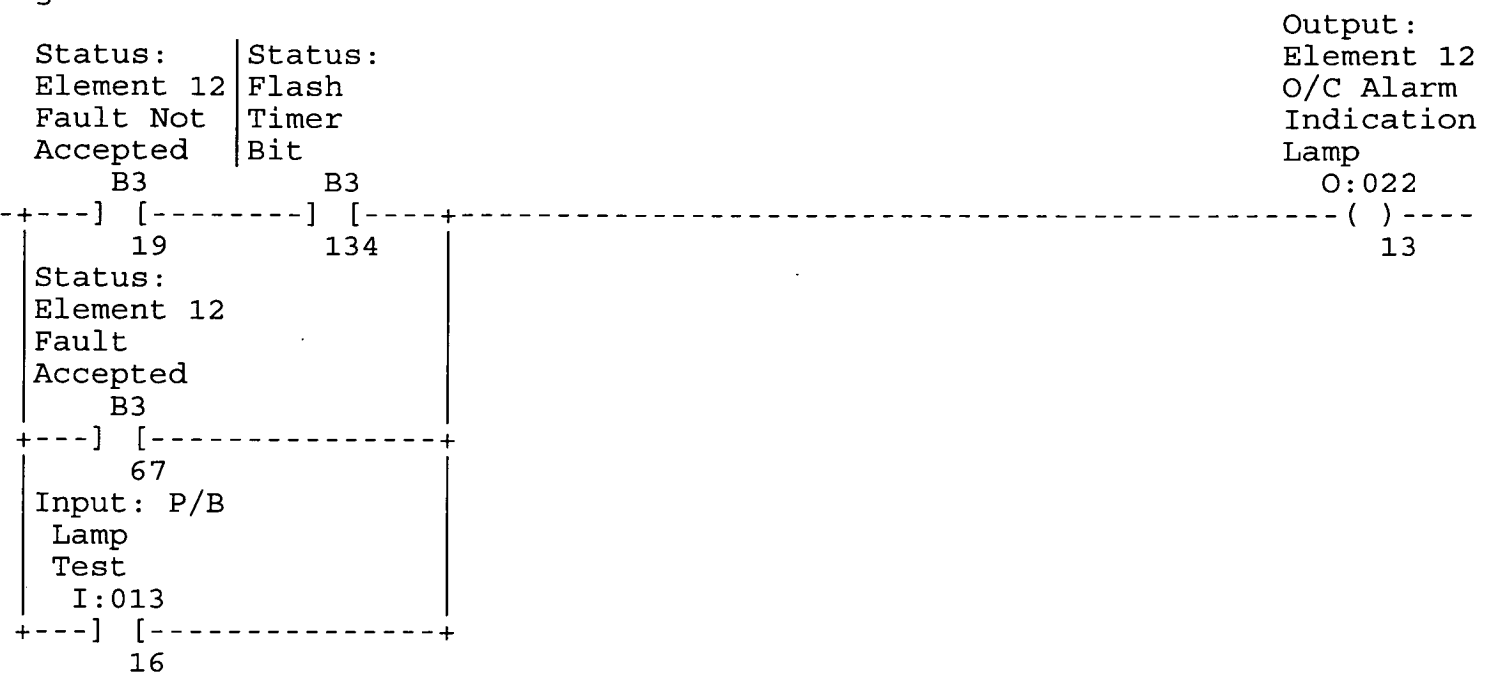
ung 6:46



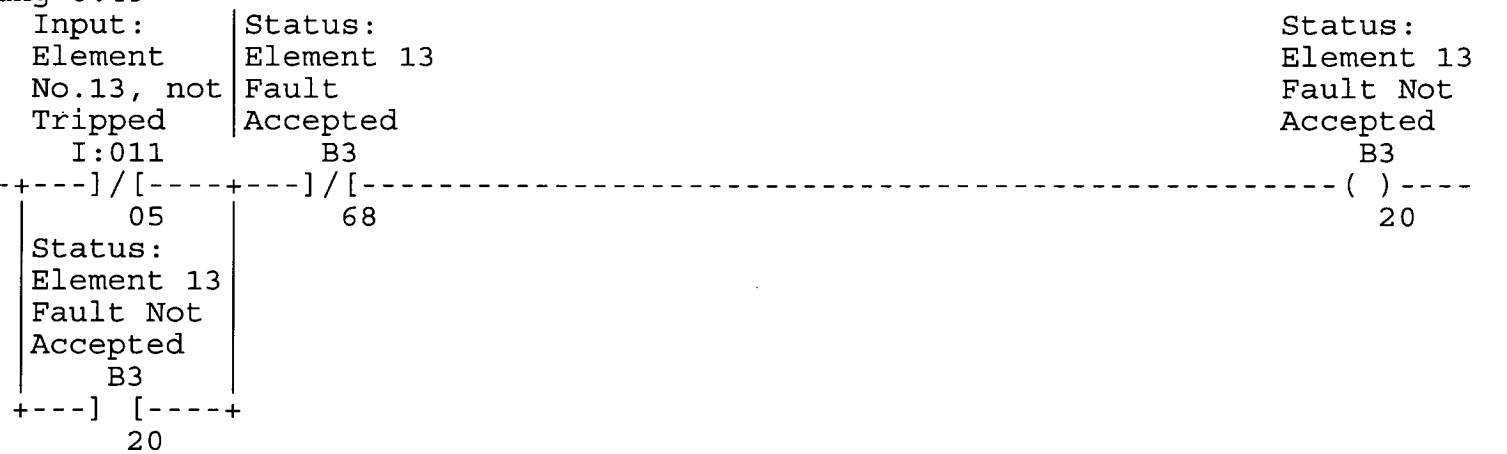
ung 6:47



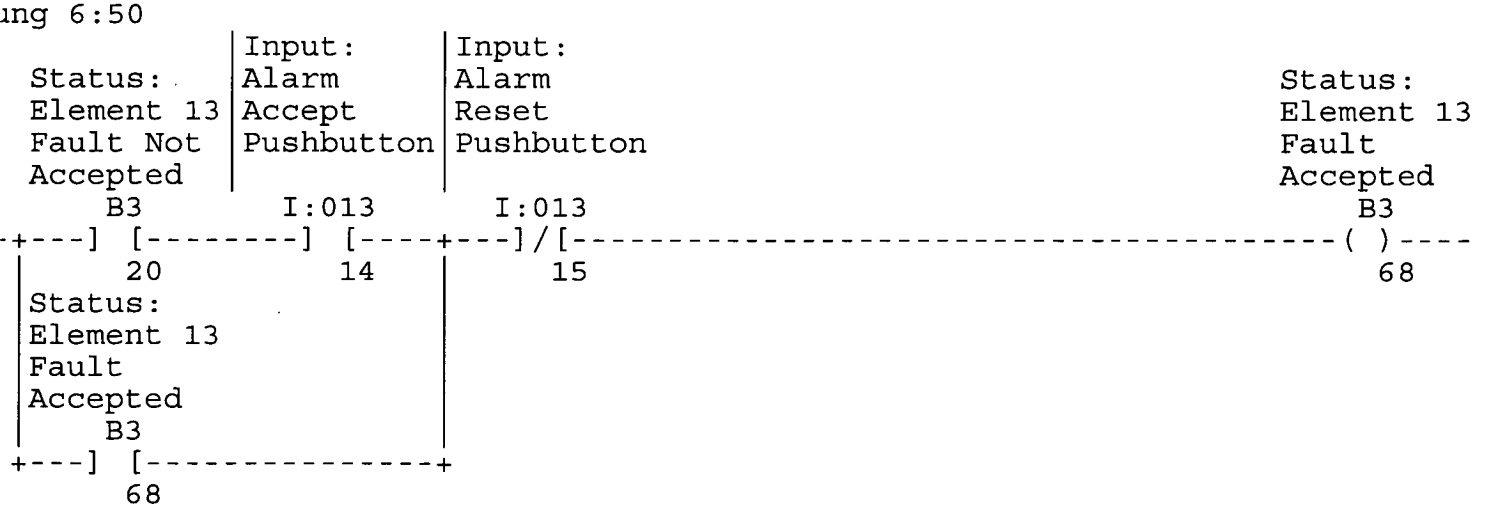
ung 6:48



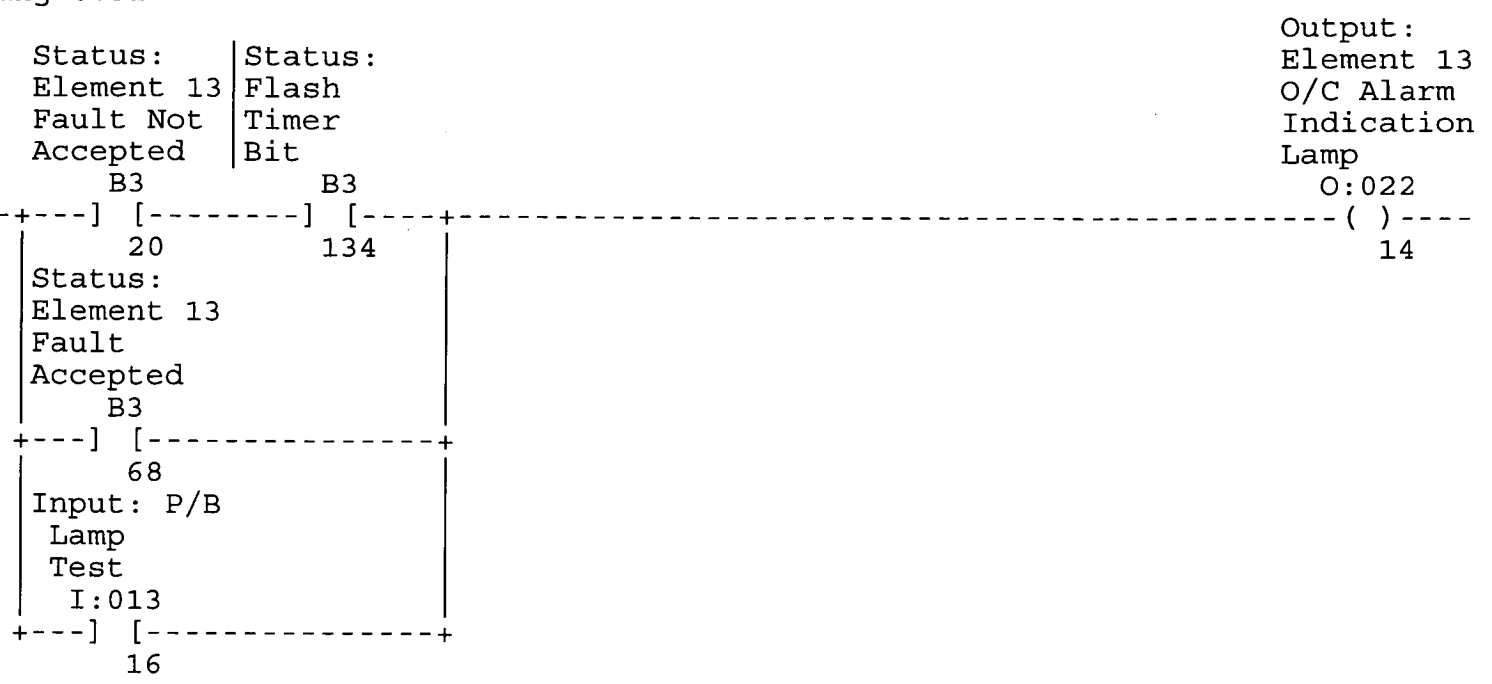
ung 6:49



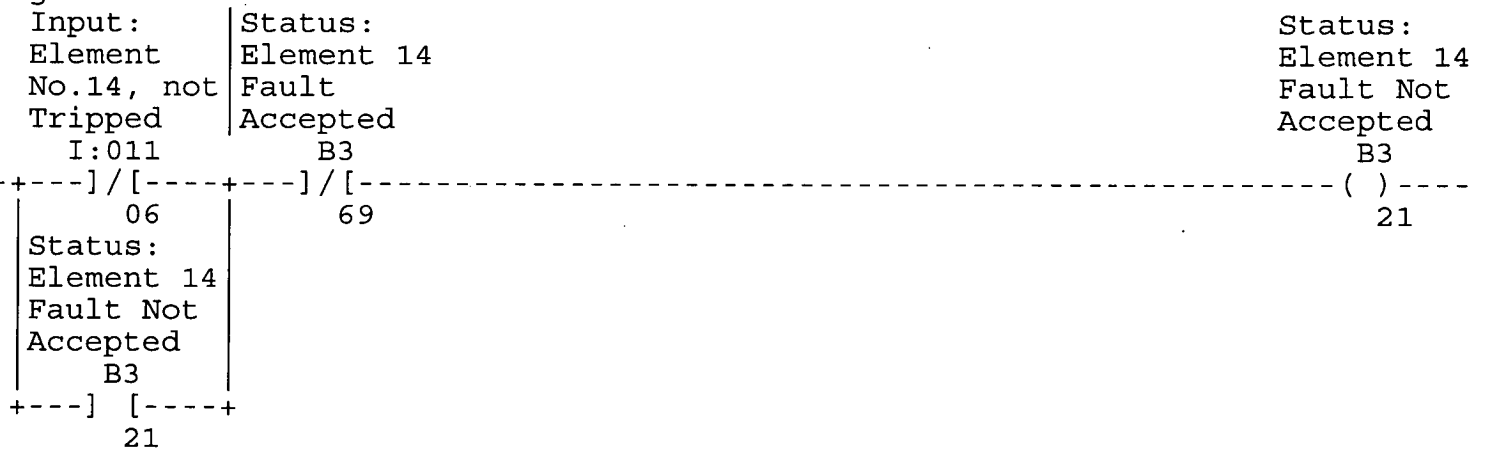
ung 6:50



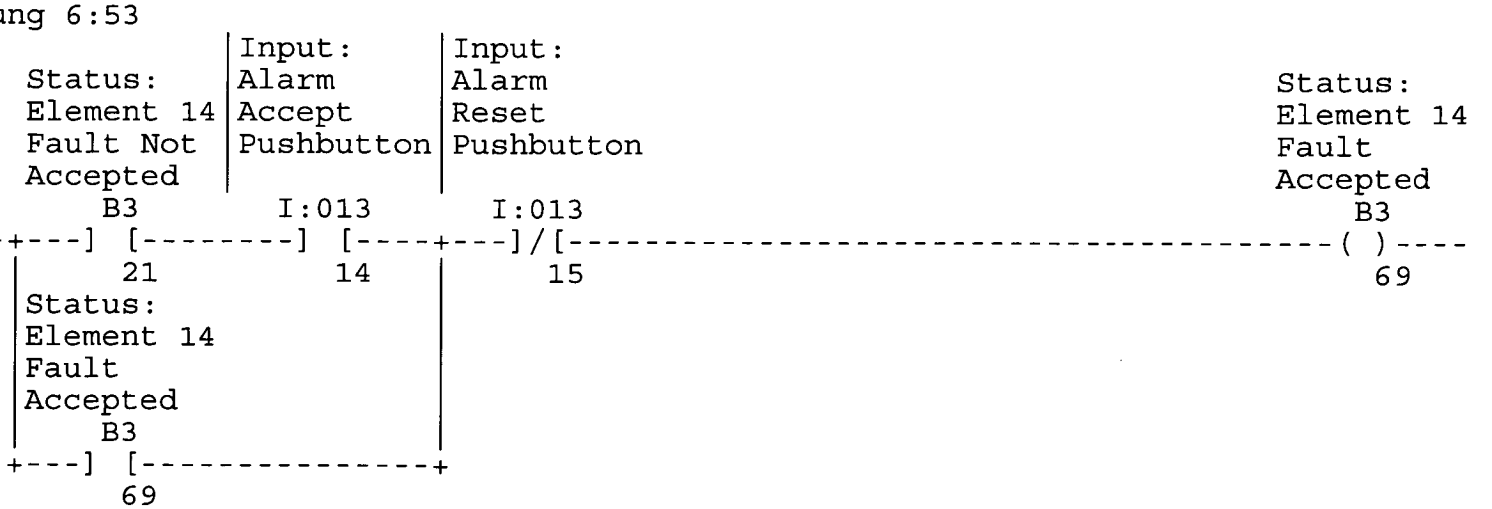
ung 6:51



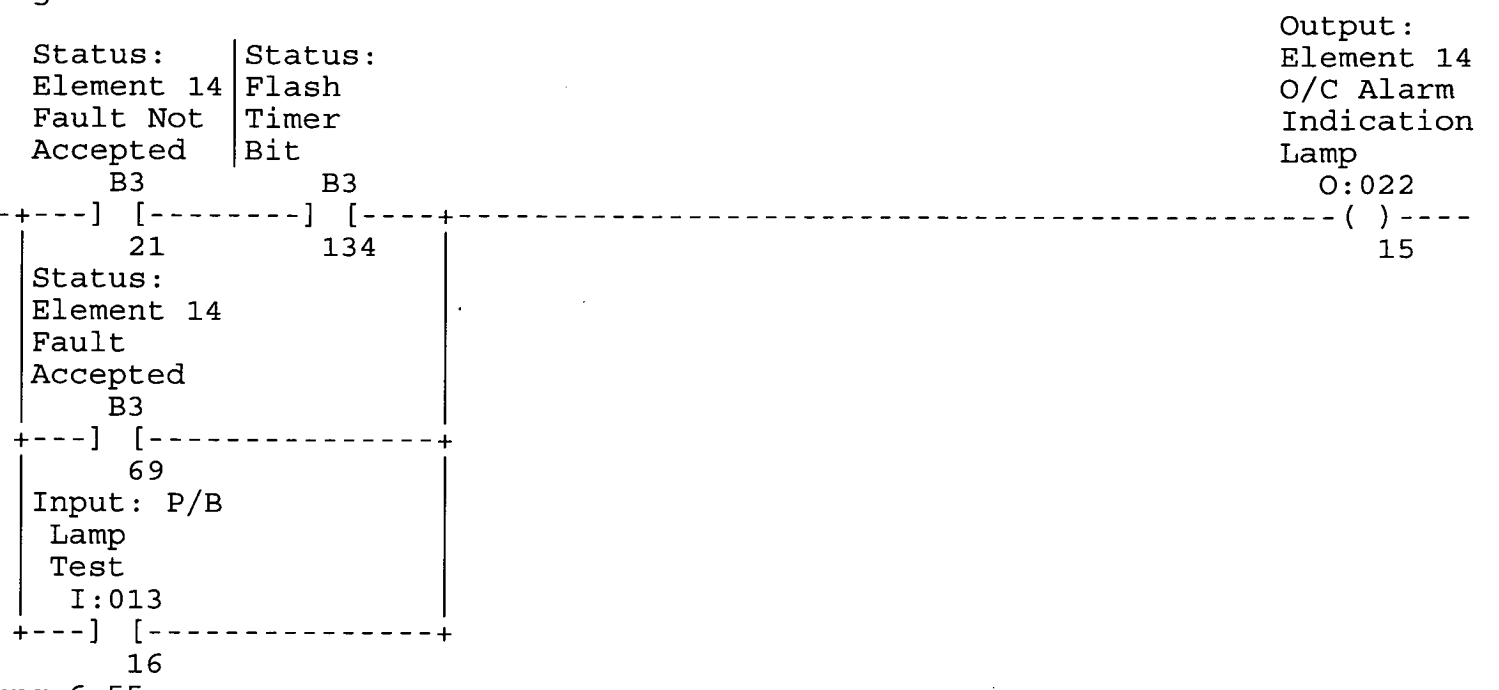
ung 6:52



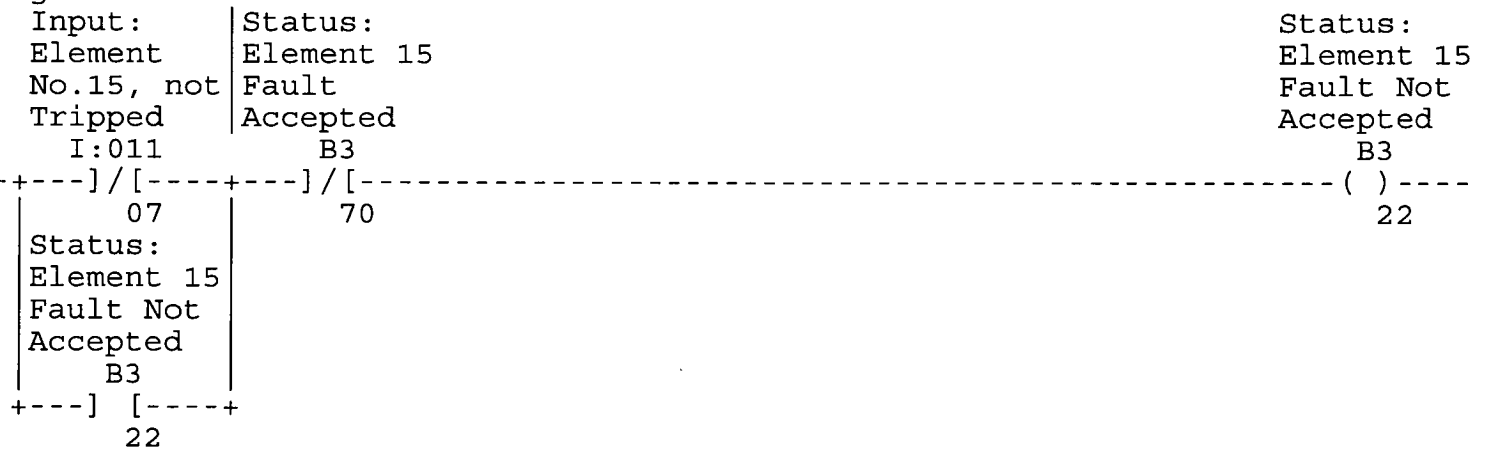
ung 6:53



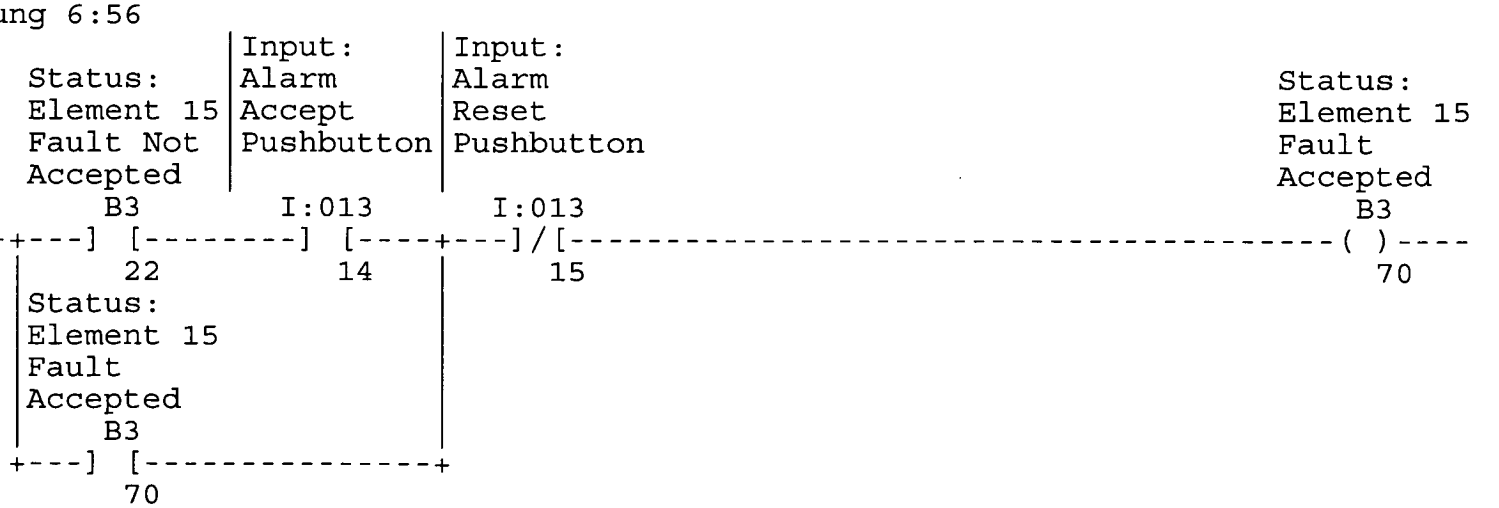
ung 6:54



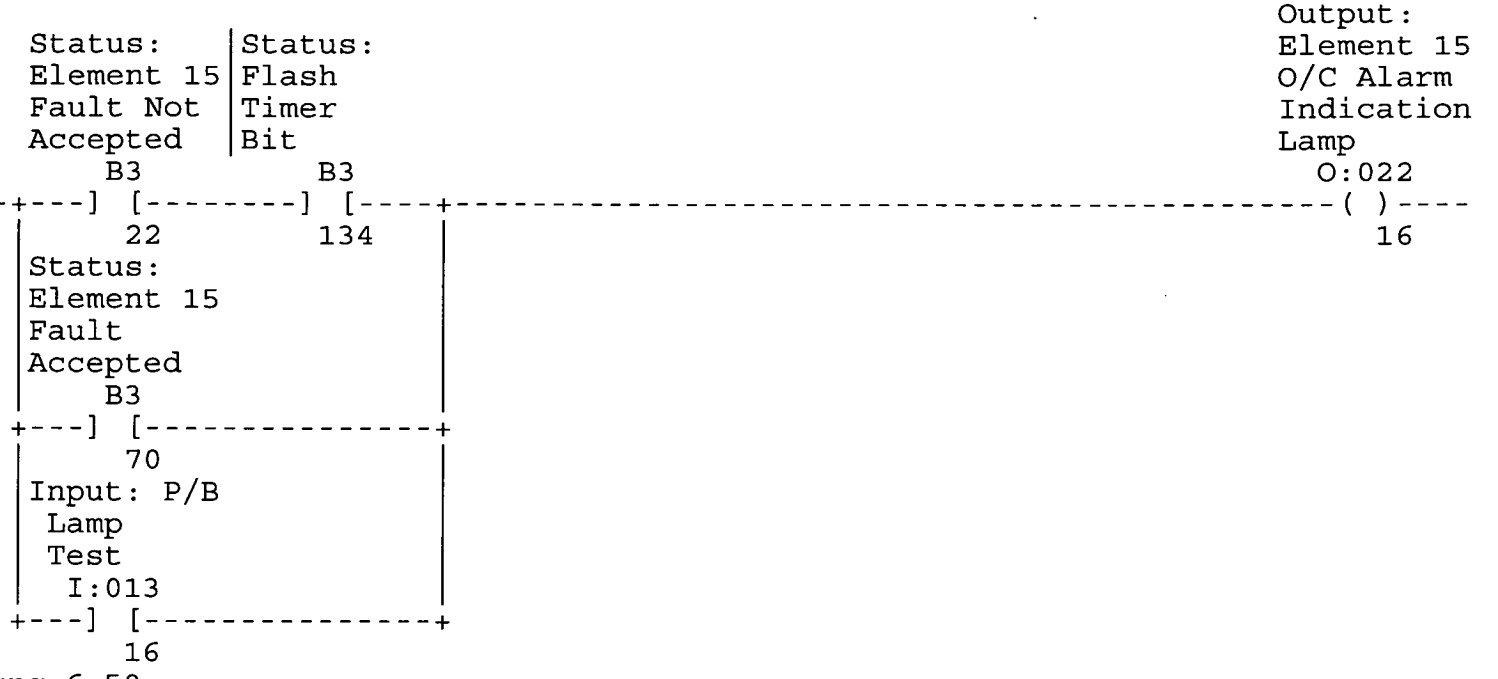
ung 6:55



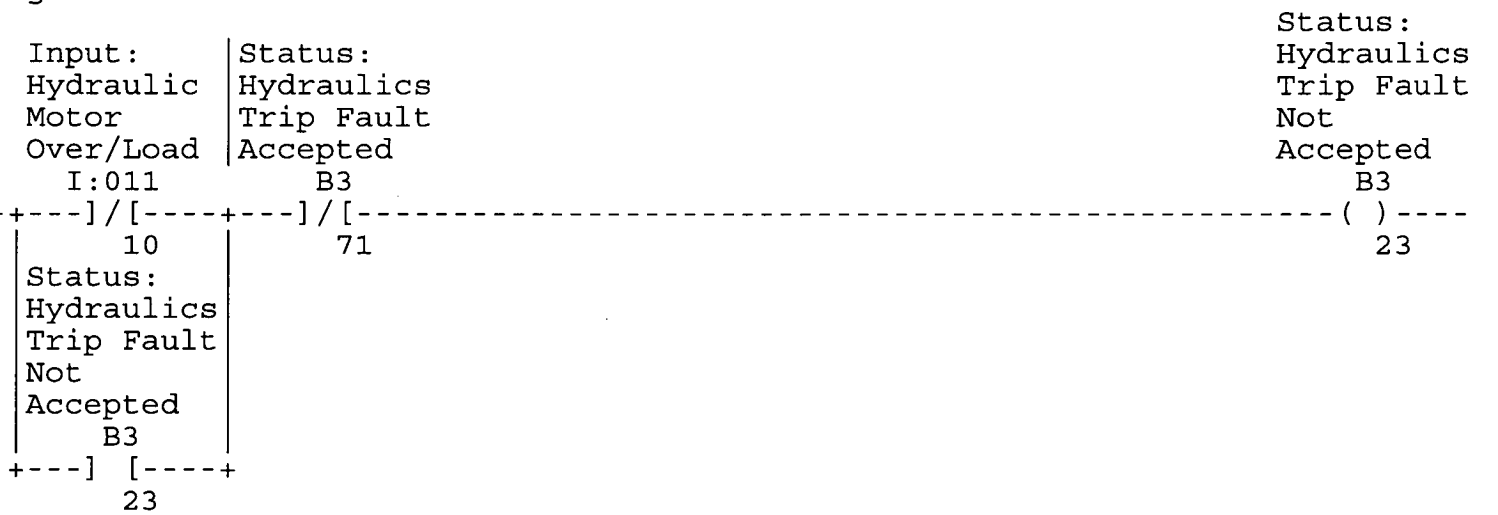
ung 6:56



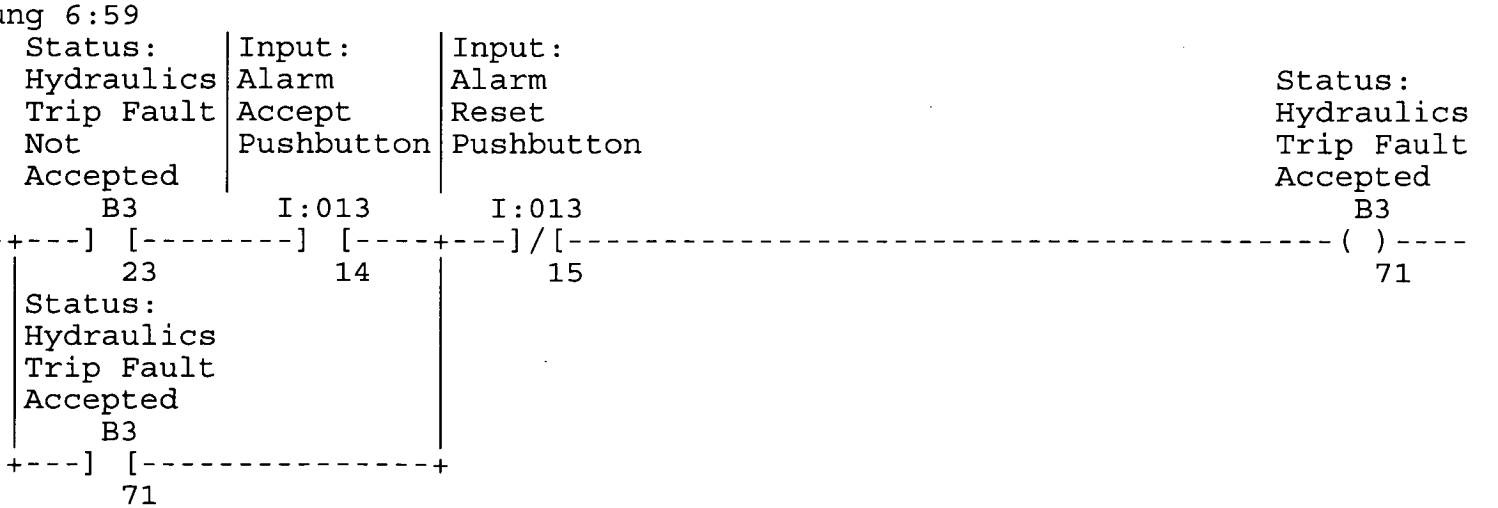
ung 6:57



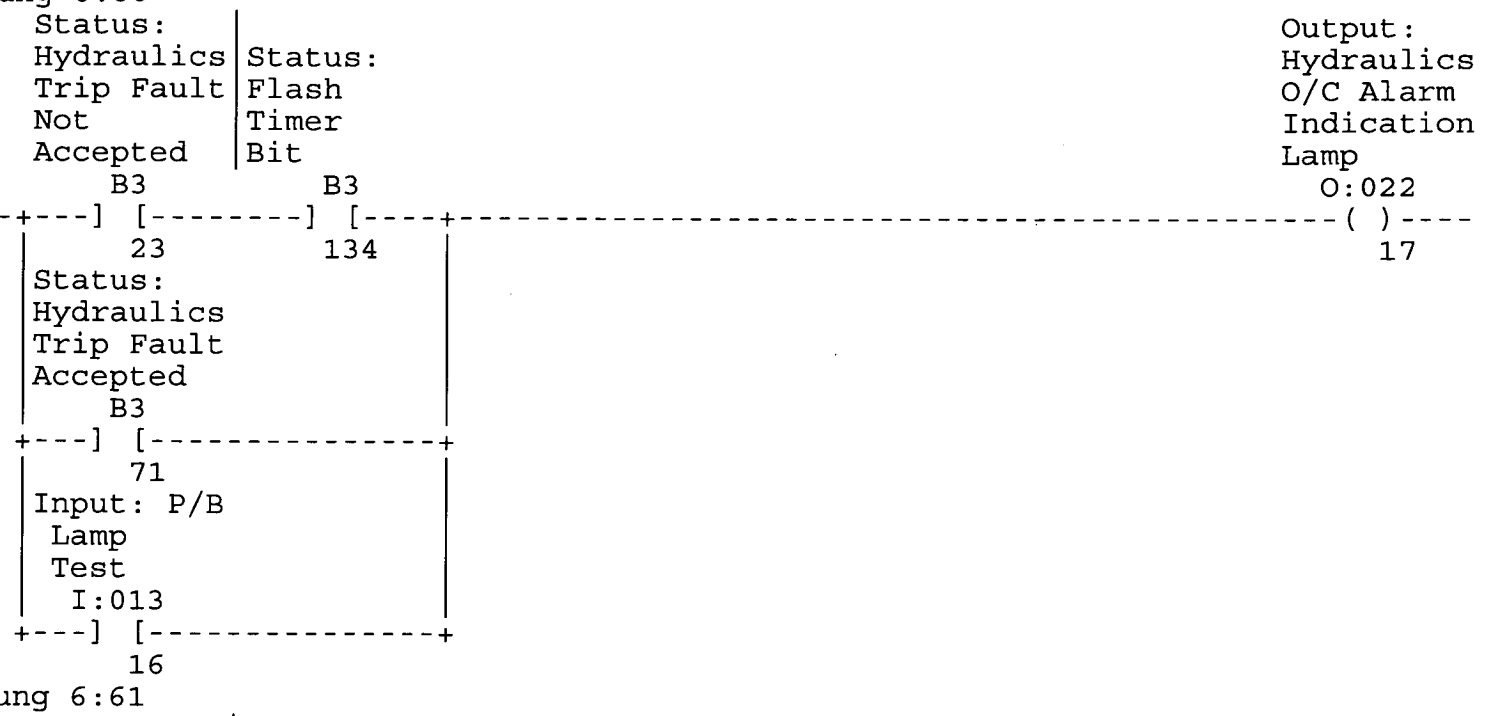
ung 6:58



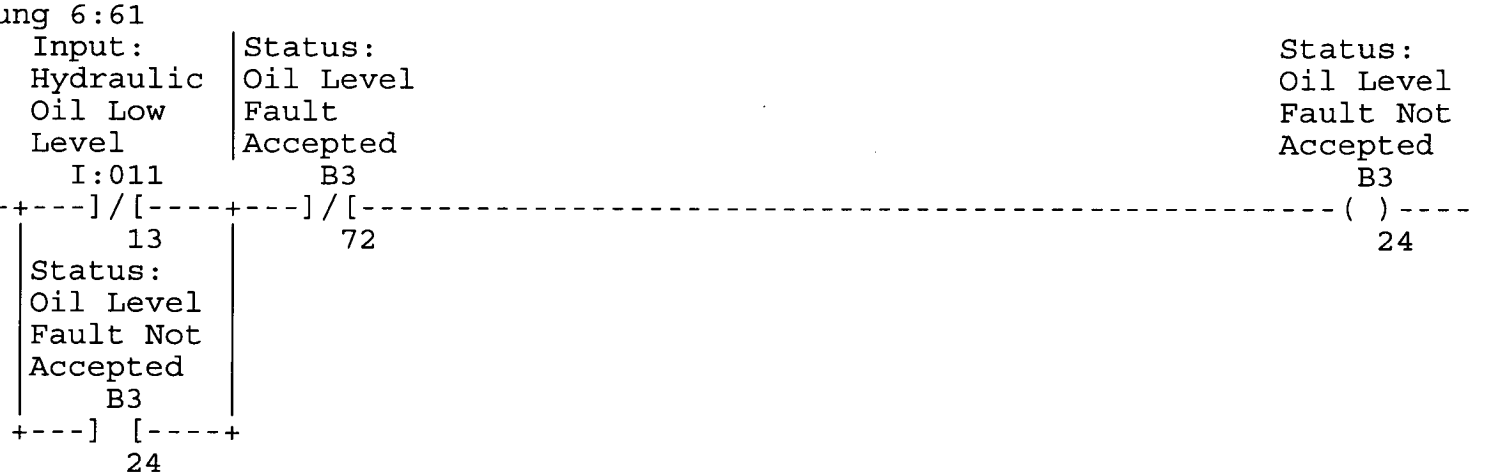
ung 6:59



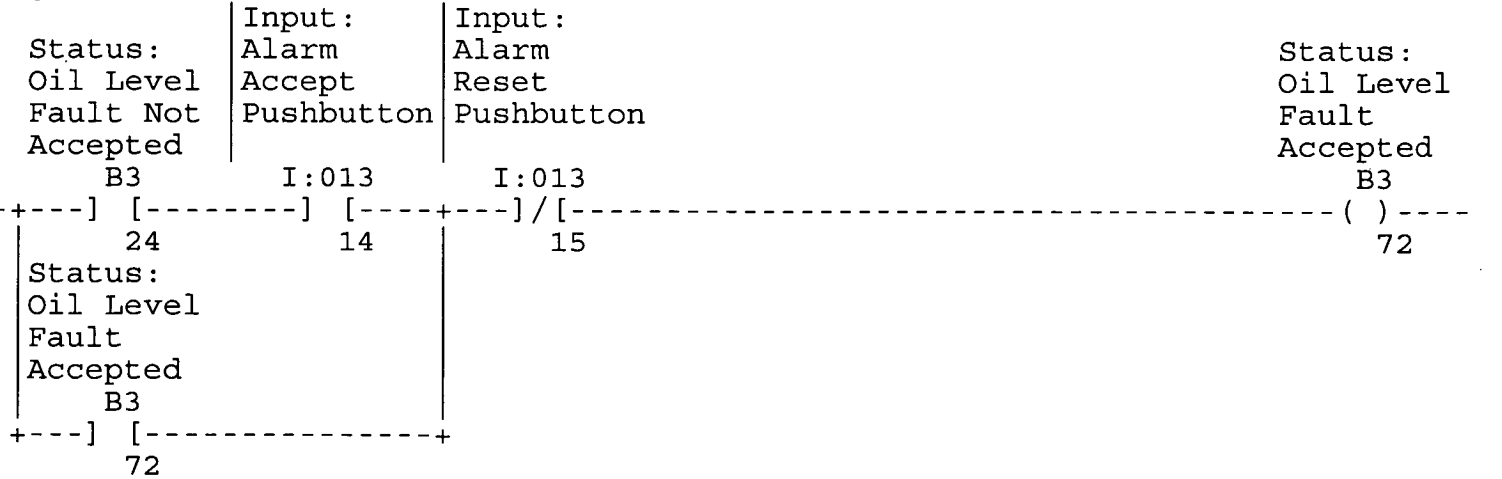
ung 6:60



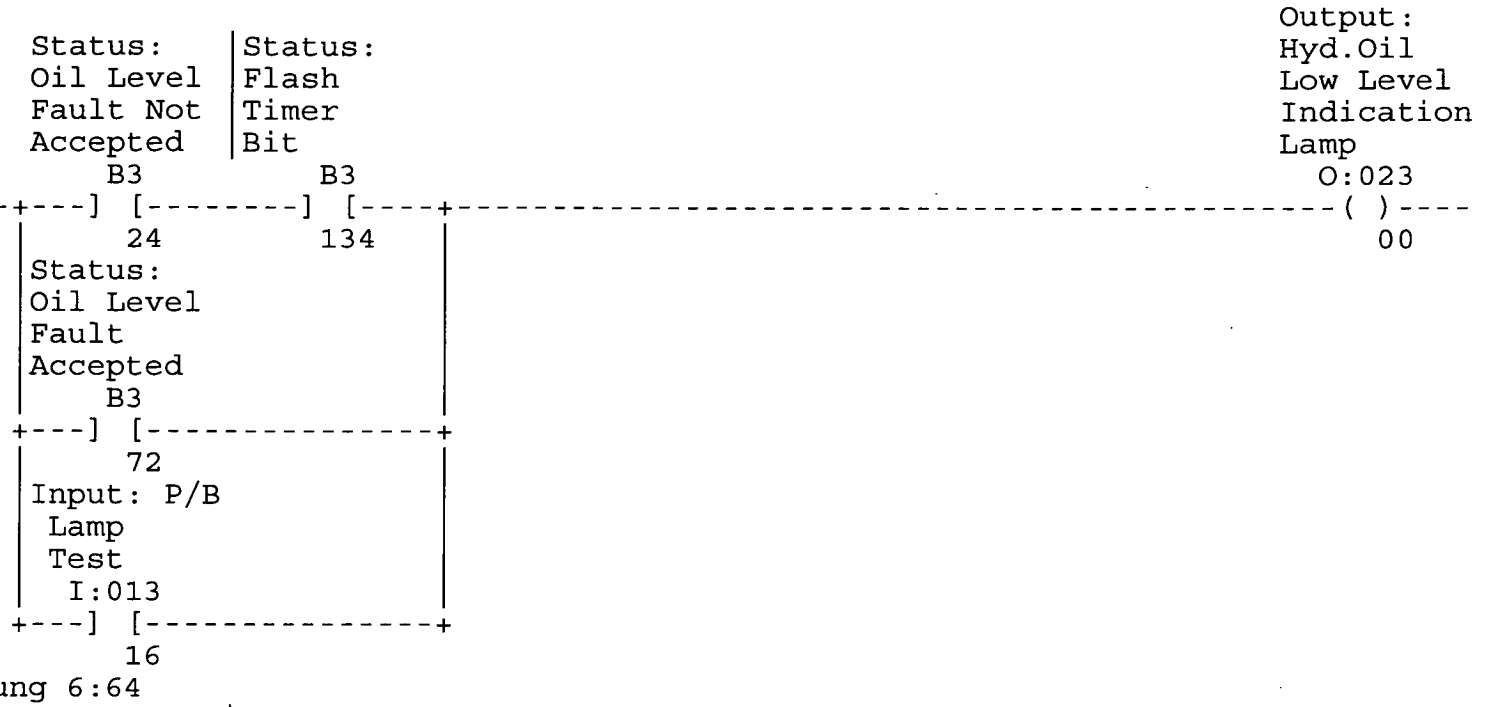
ung 6:61



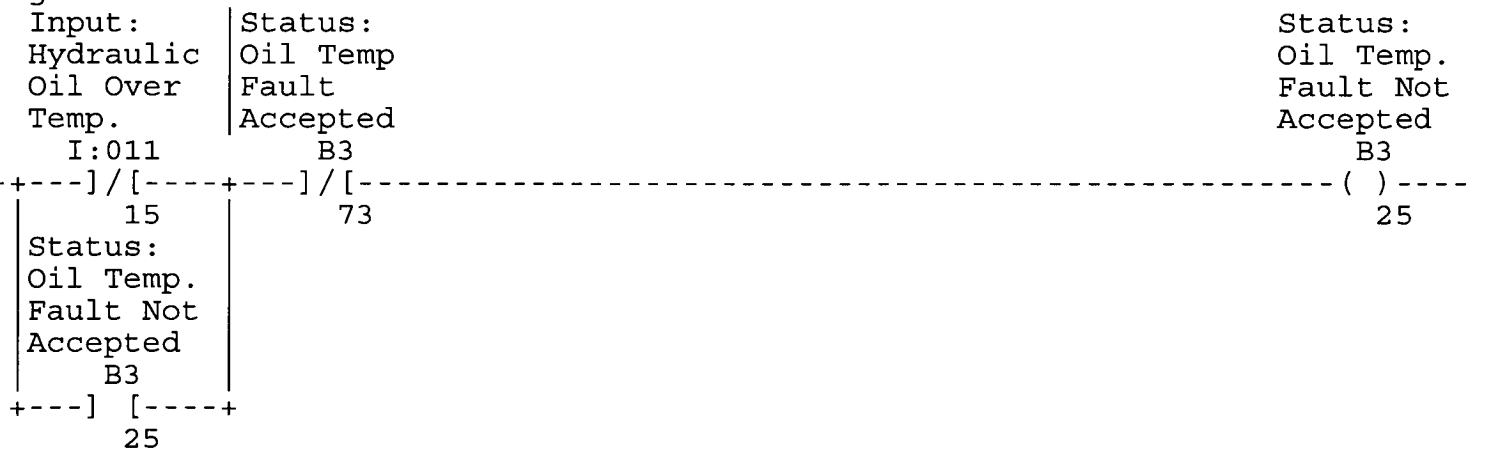
ung 6:62



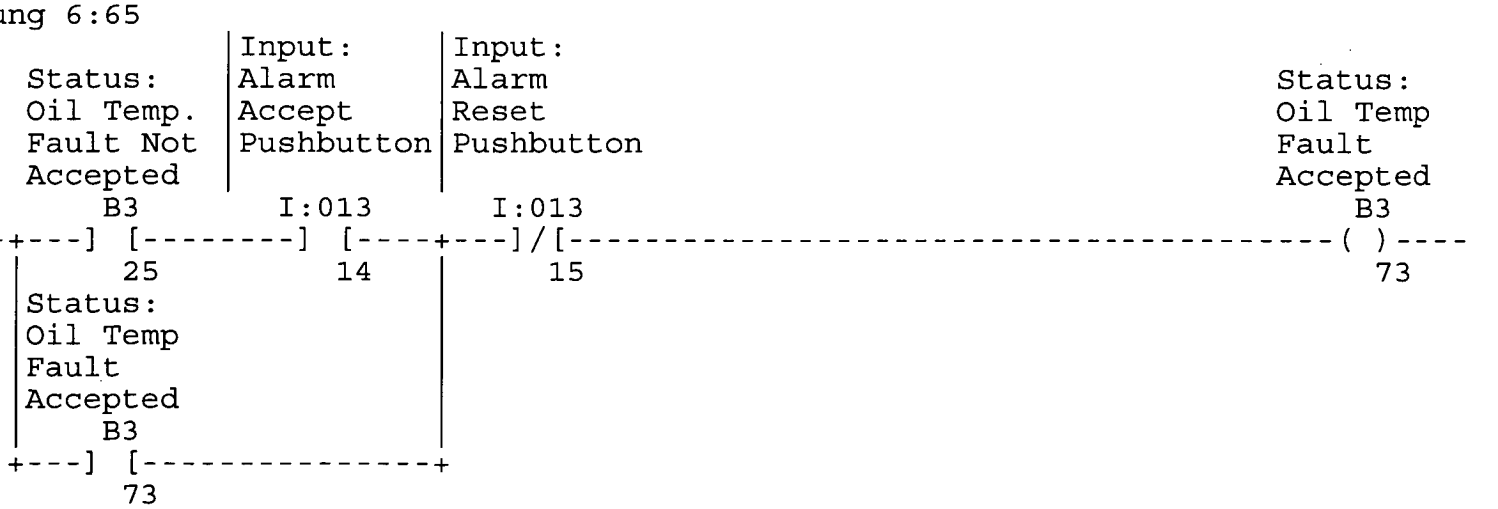
ung 6:63



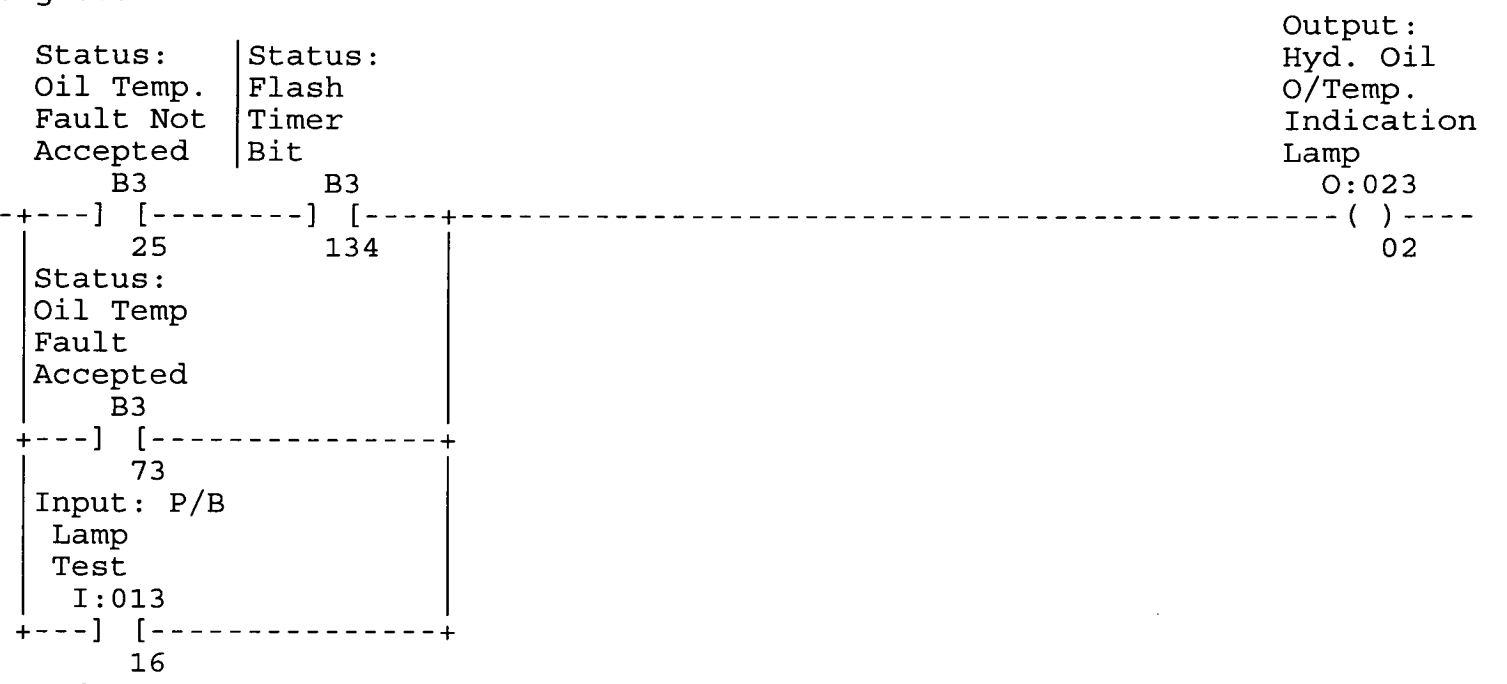
ung 6:64



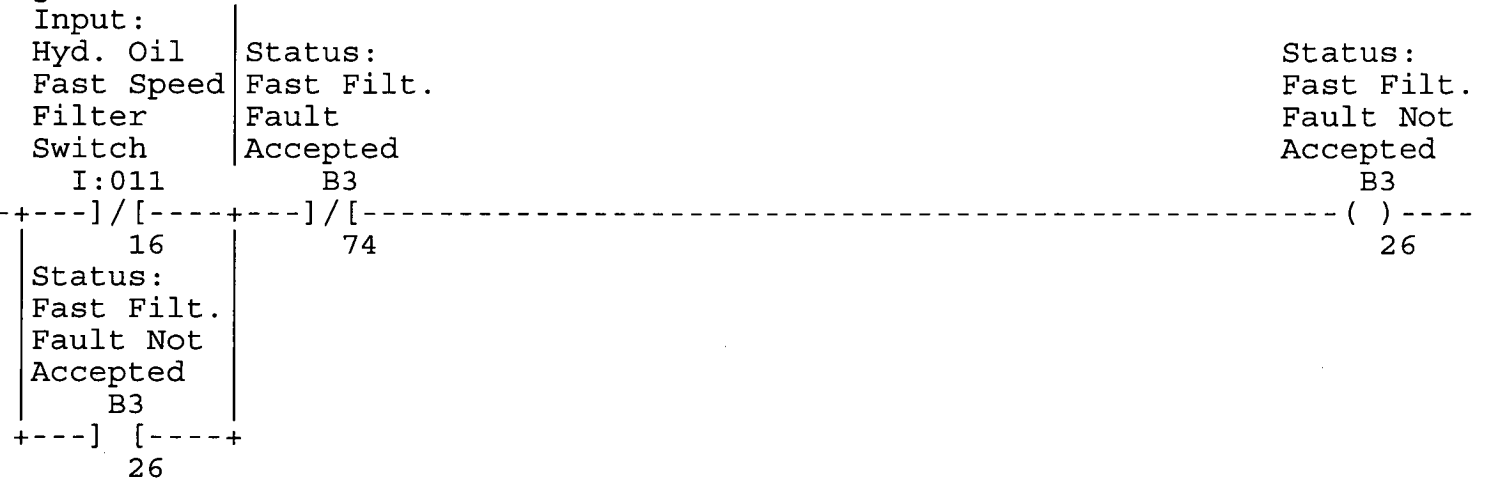
ung 6:65



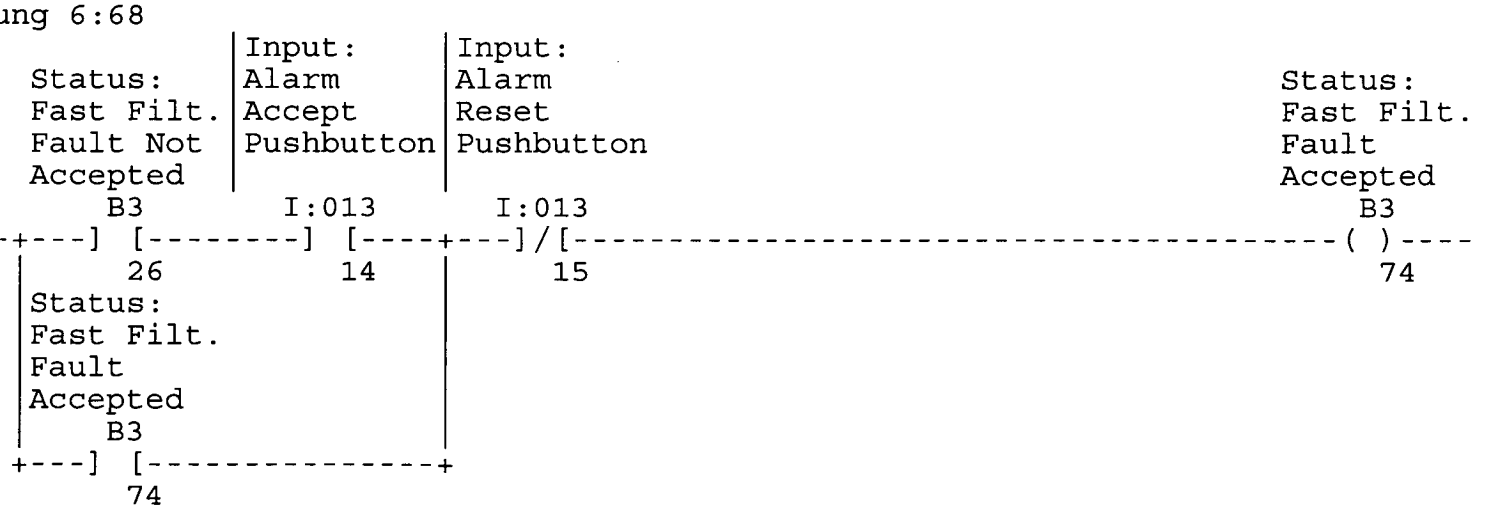
ung 6:66



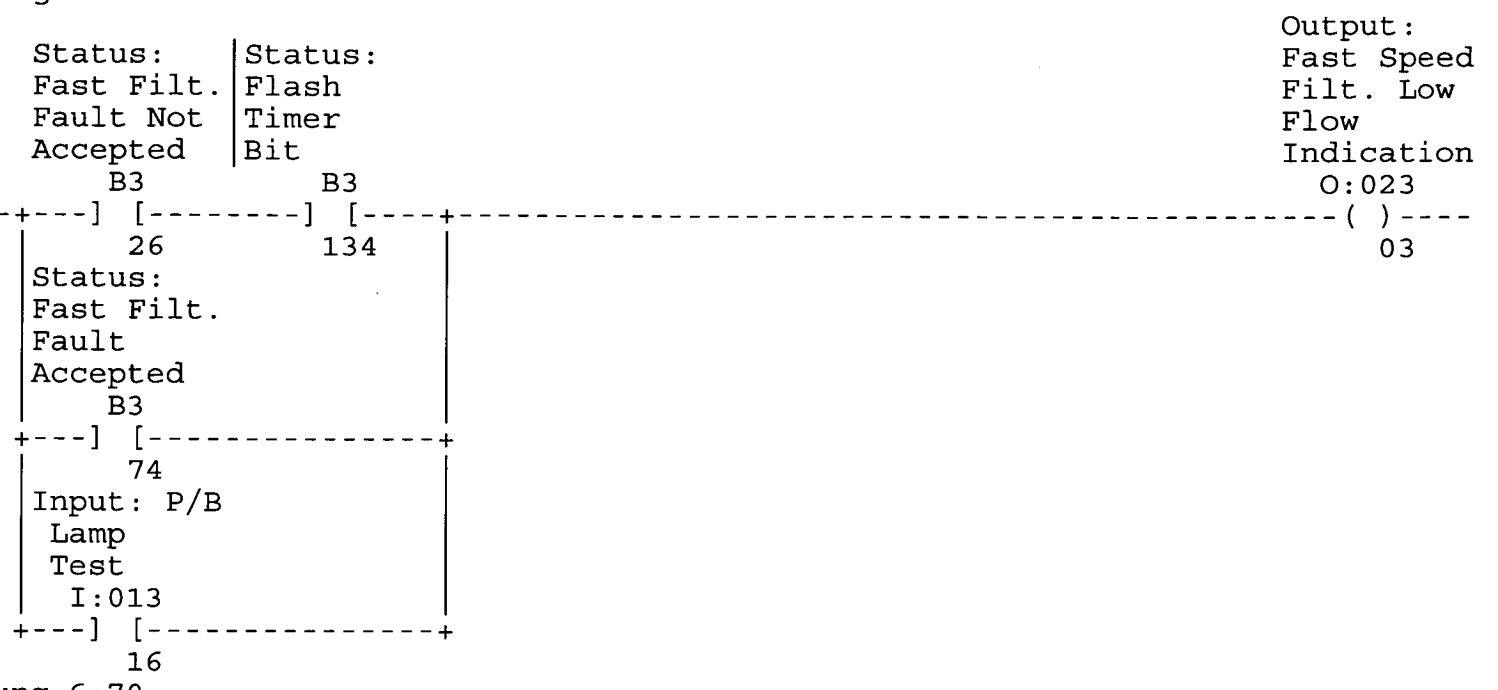
ung 6:67



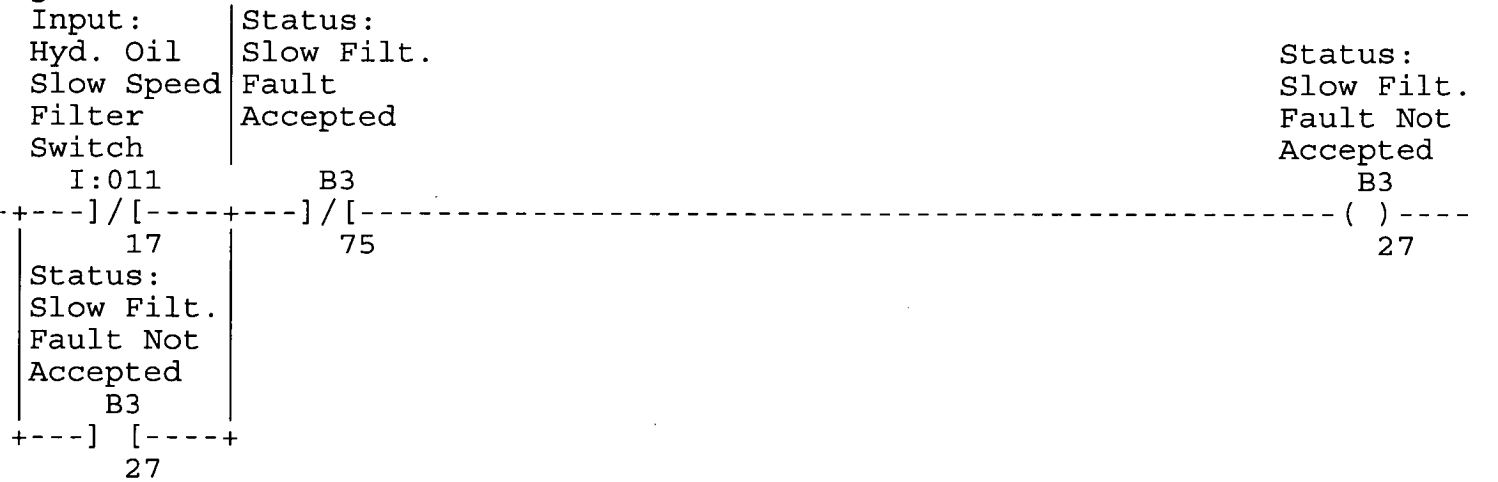
ung 6:68



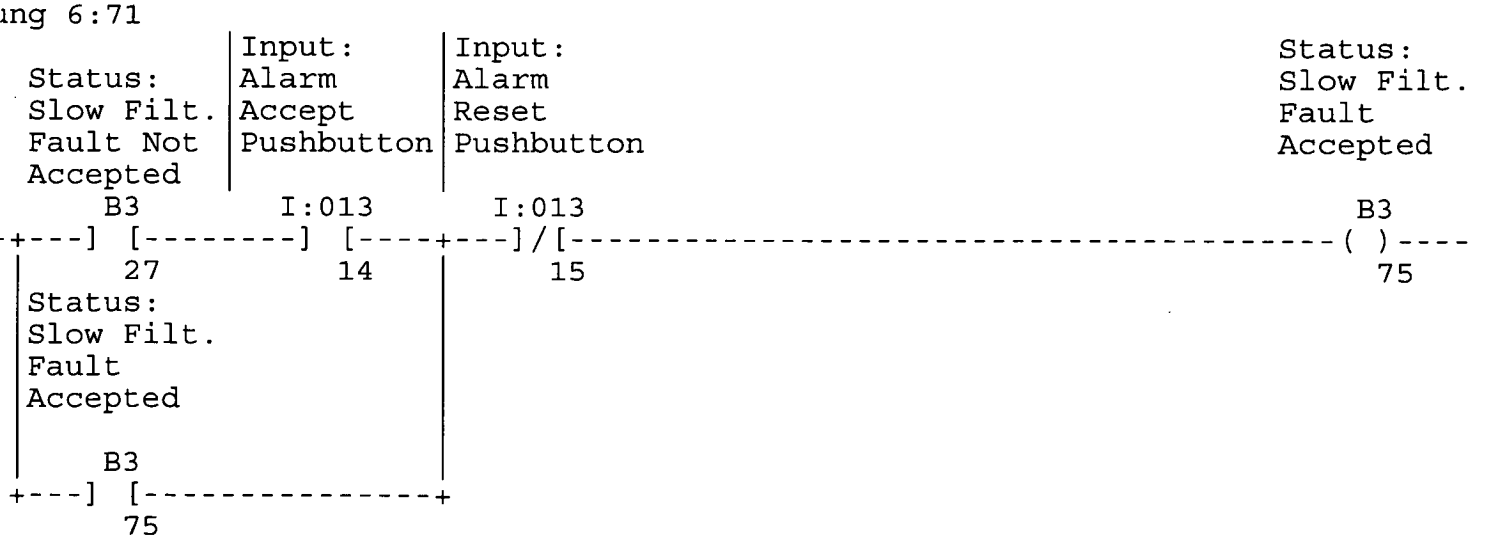
ung 6:69



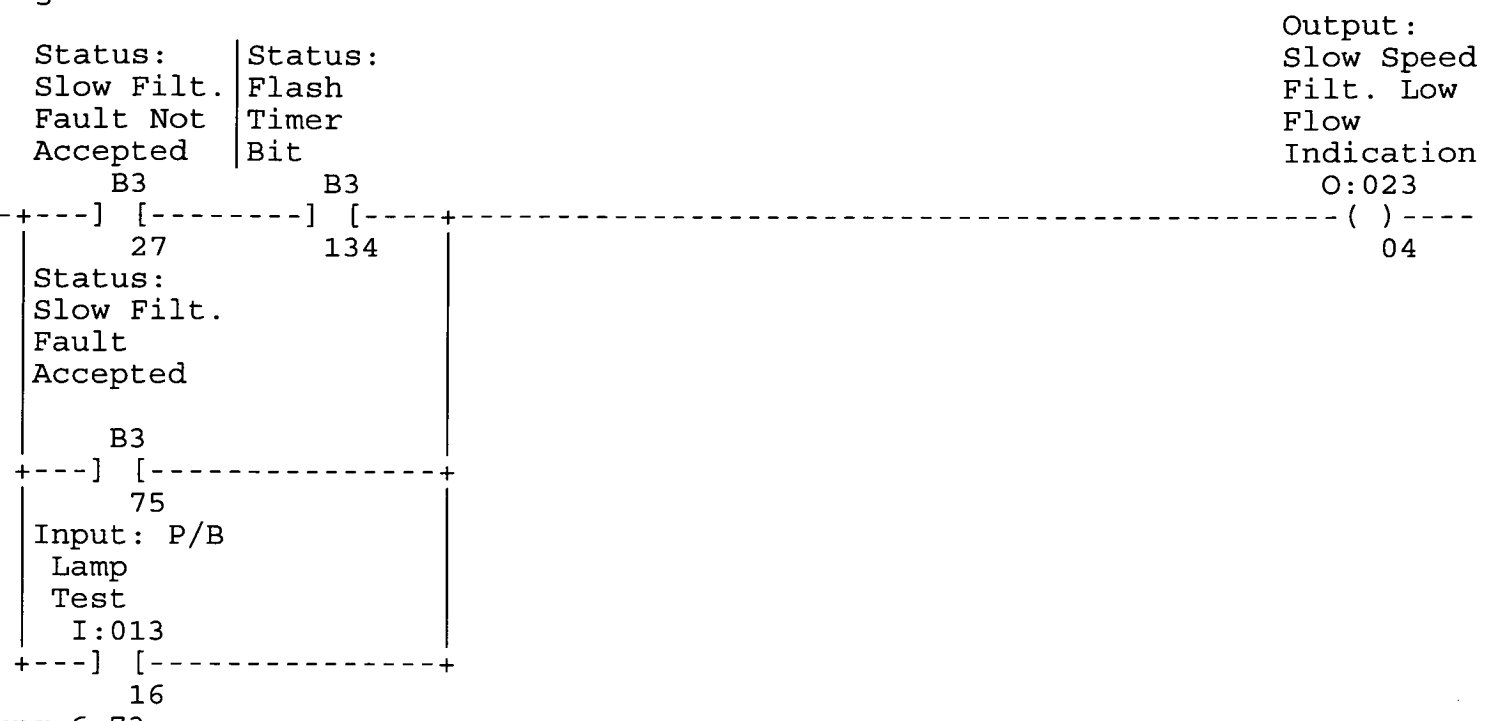
ung 6:70



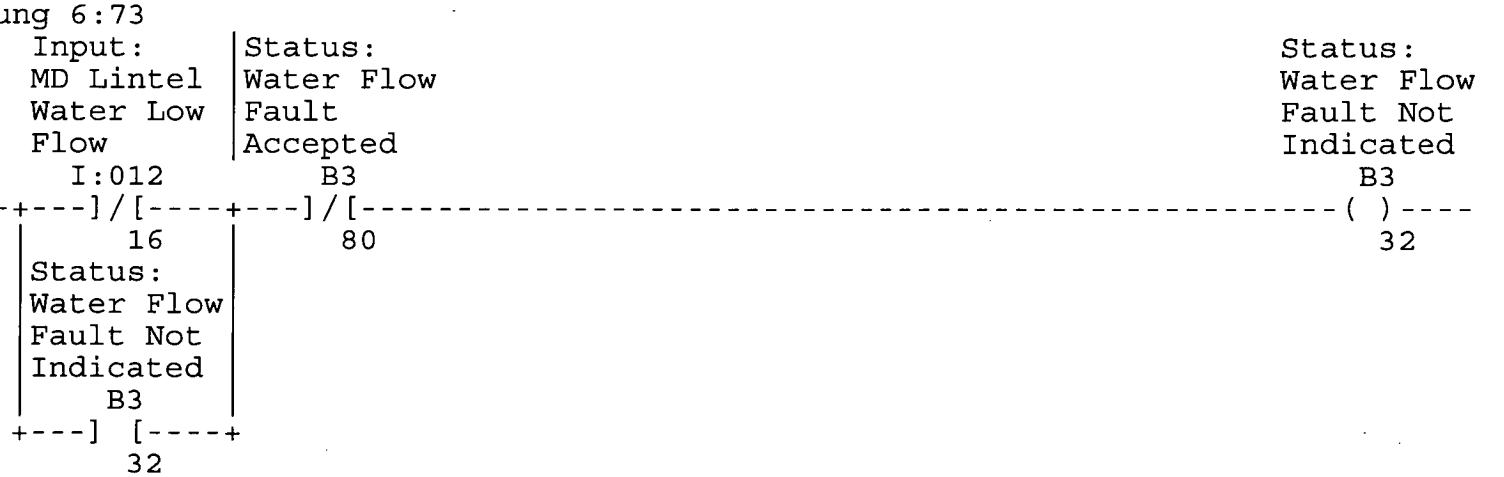
ung 6:71



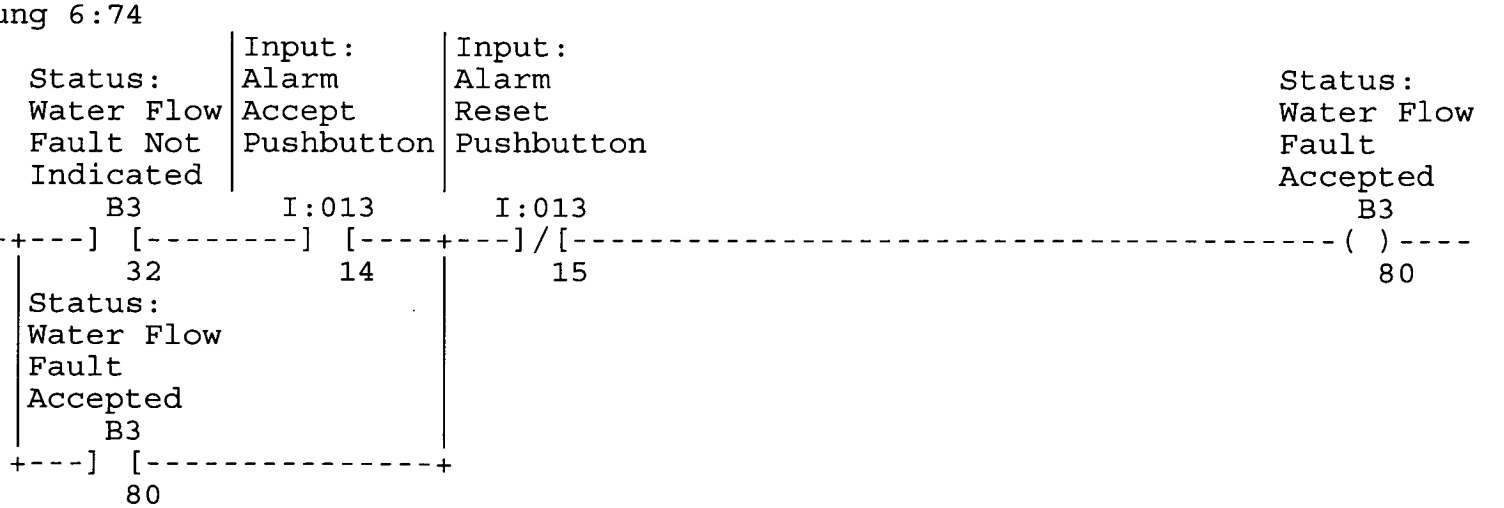
ung 6:72



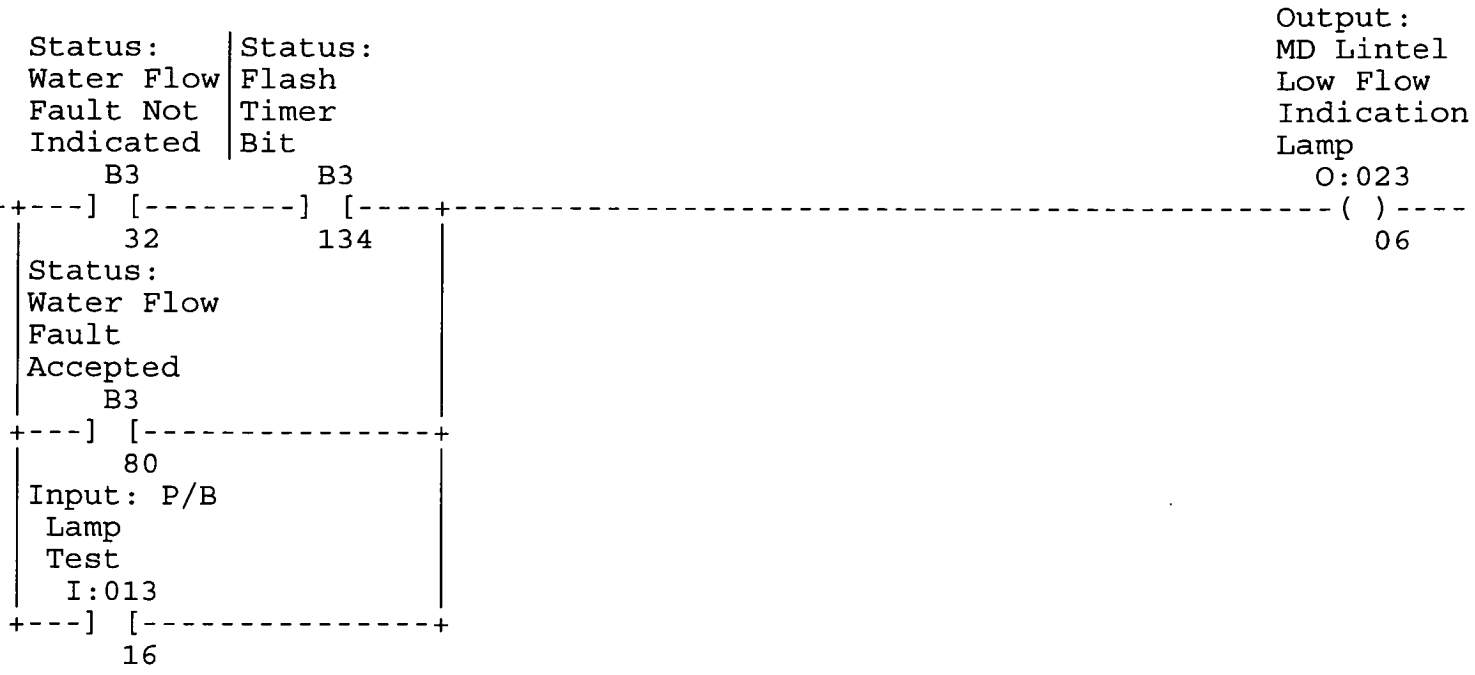
ung 6:73



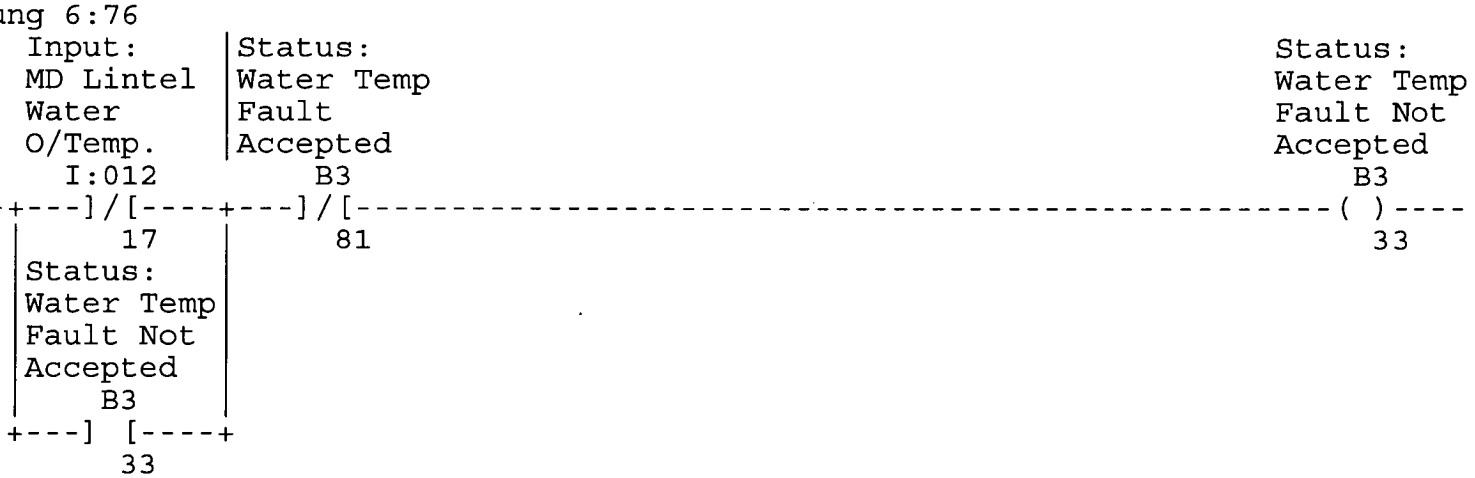
ung 6:74



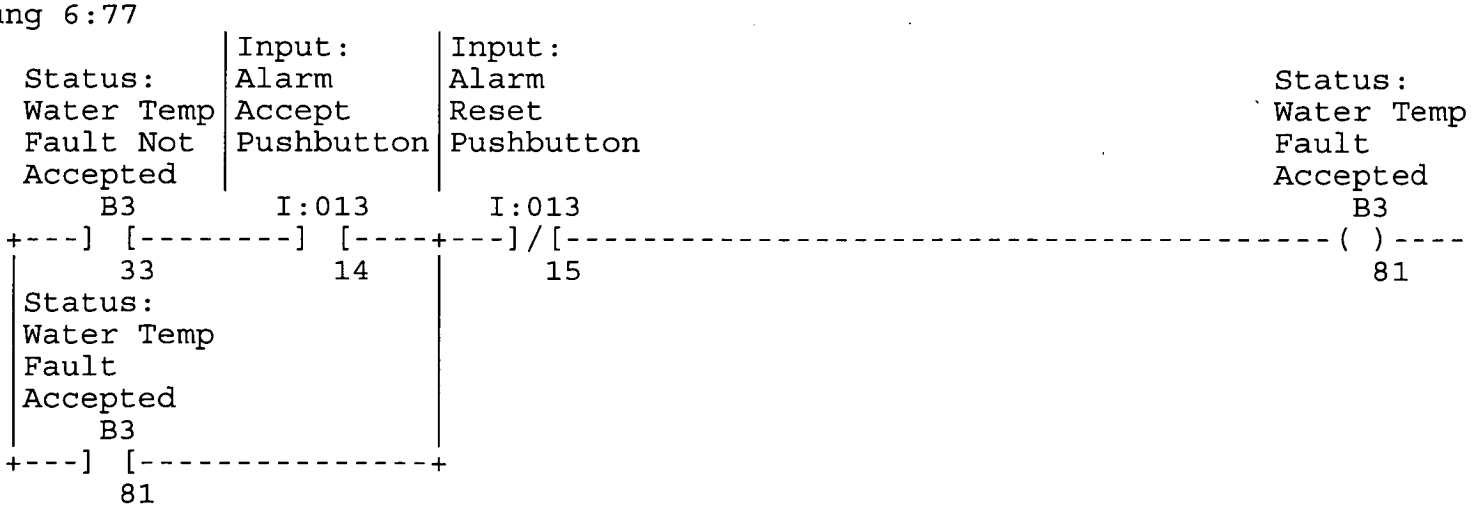
ung 6:75



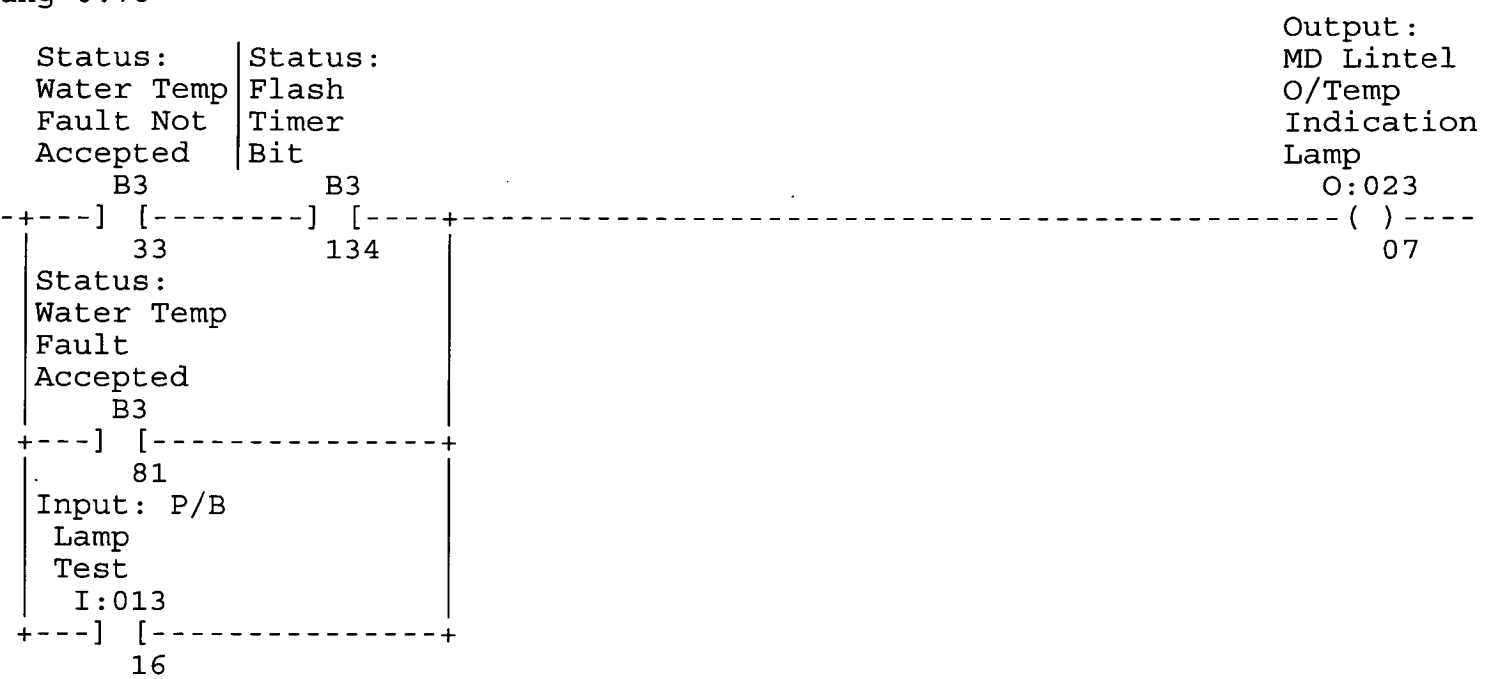
ung 6:76



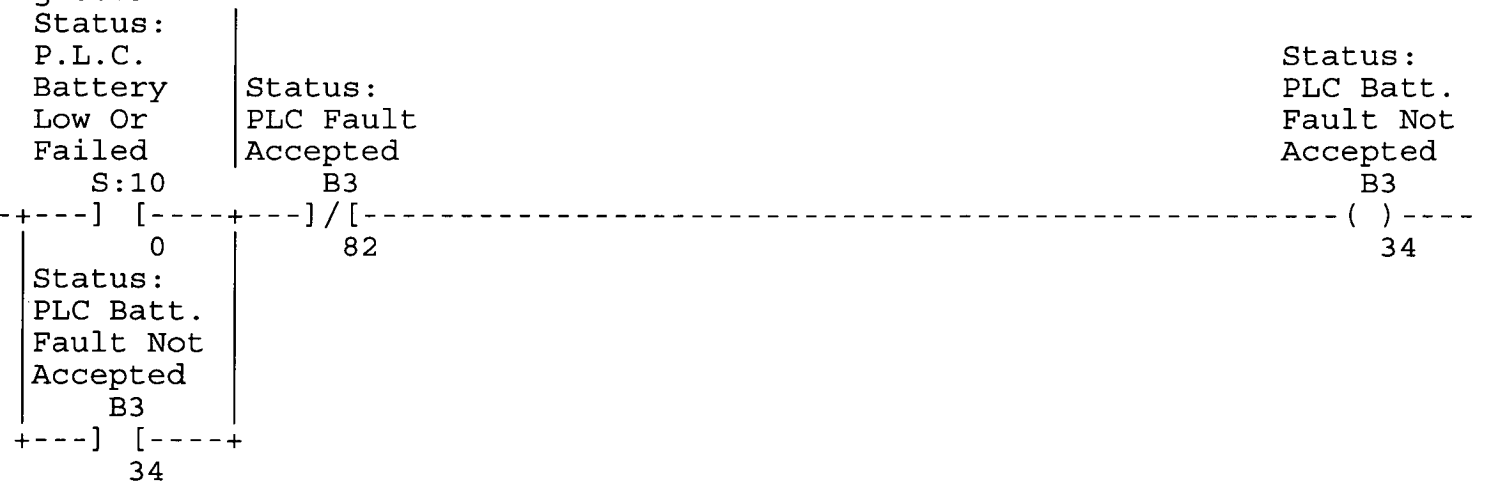
ung 6:77



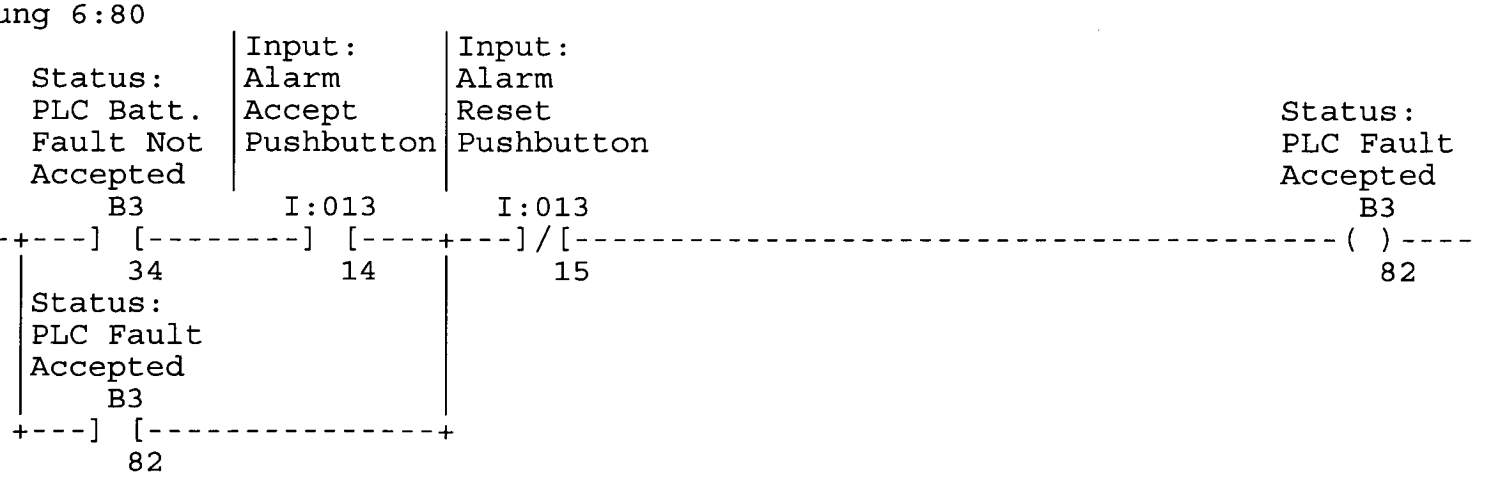
ung 6:78



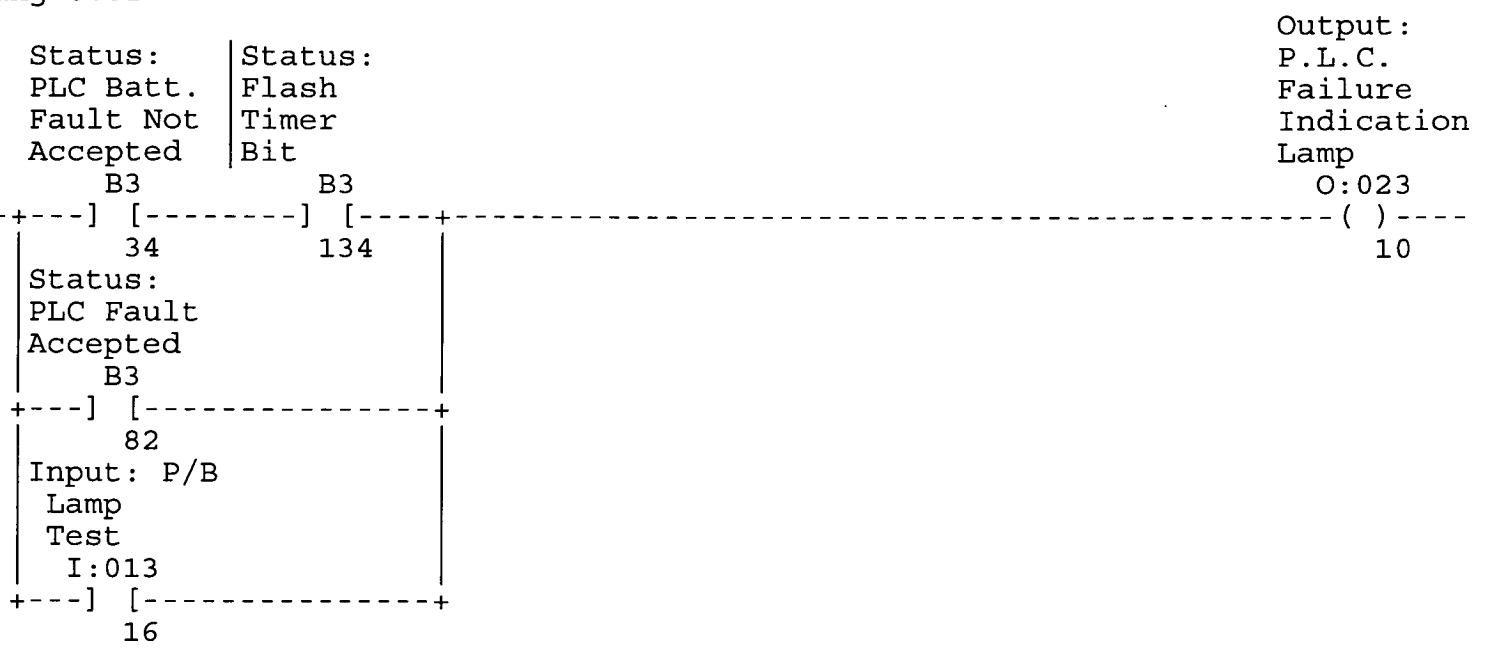
ung 6:79



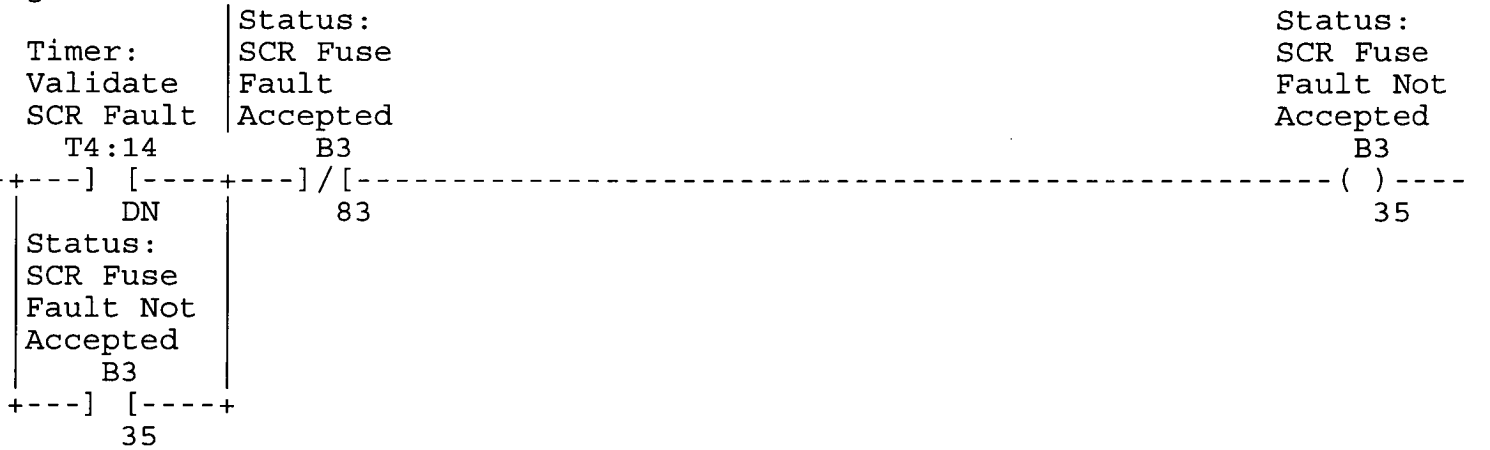
ung 6:80



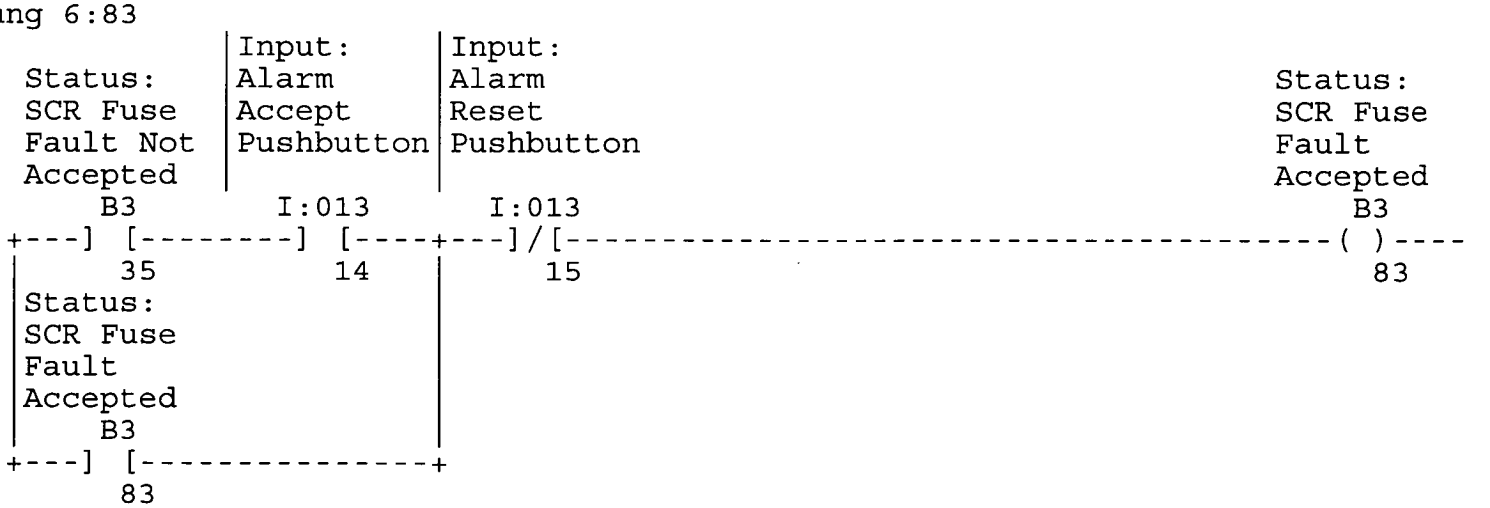
ung 6:81



ung 6:82

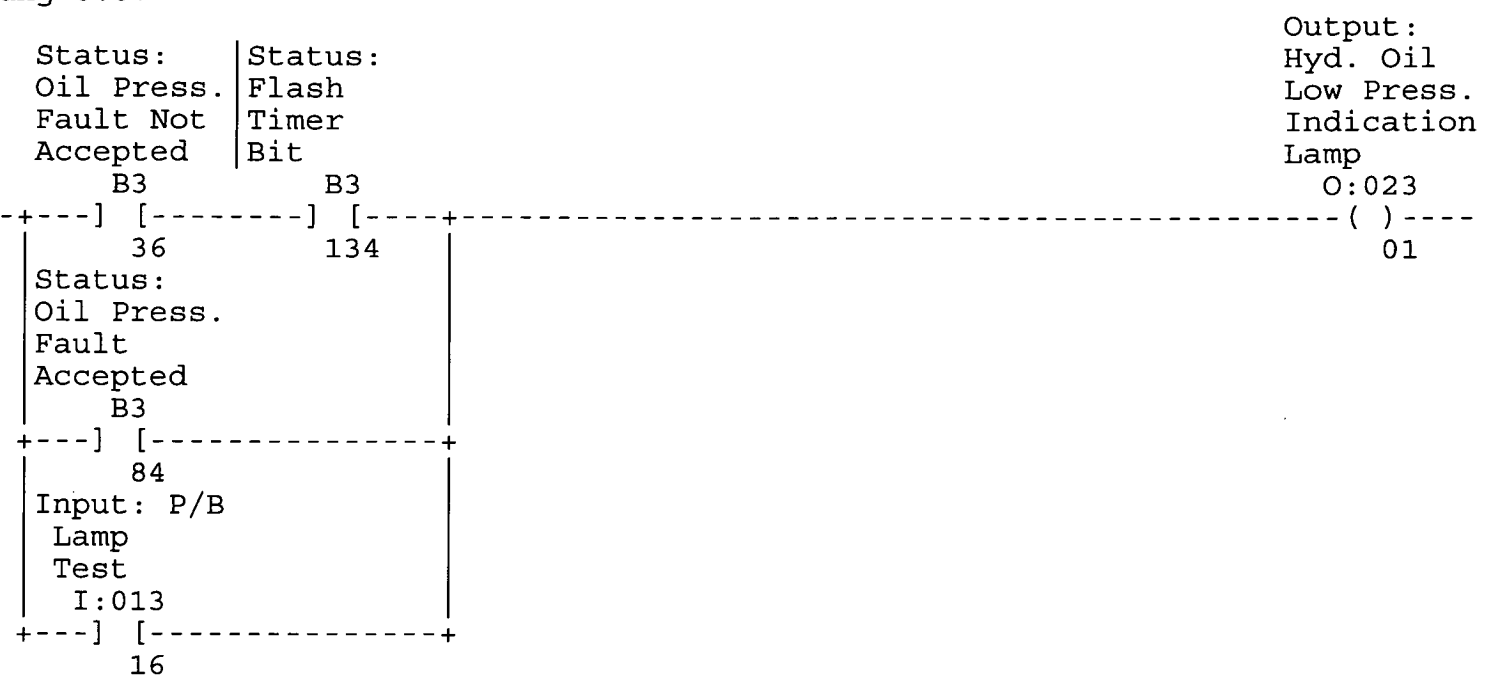


ung 6:83

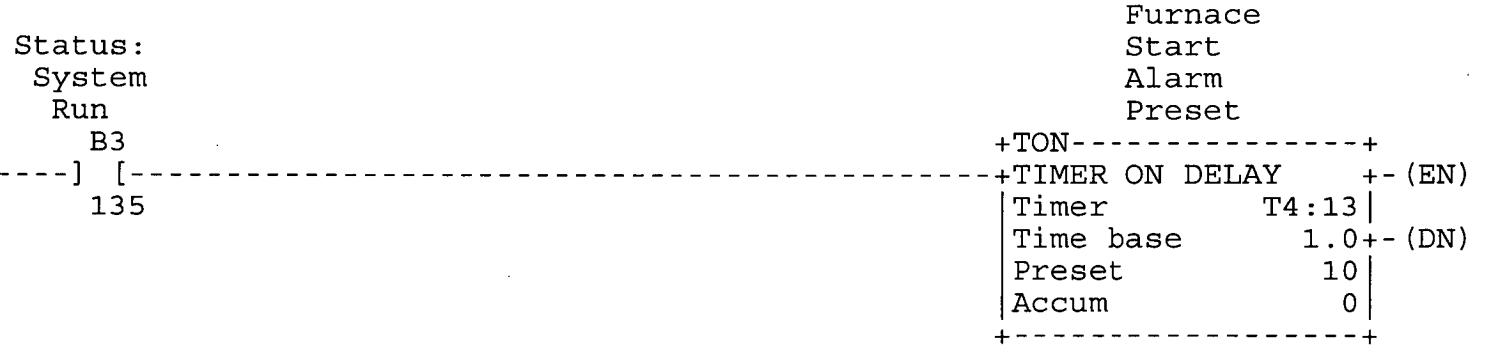


```
ung 6:84
  Status:    |Status:                                                    Output:
  SCR Fuse   |Flash                                                      SCR Blown
  Fault Not  |Timer                                                      Fuse
  Accepted   |Bit                                                        Mimic
      B3           B3                                                     O:024
-+---] [--------] [----+-------------------------------------------------( )----
 |      35         134  |                                                  00
 |Status:               |
 |SCR Fuse              |
 |Fault                 |
 |Accepted              |
 |    B3                |
 +---] [----------------+
 |      83
 |Input: P/B
 | Lamp
 | Test
 |  I:013
 +---] [----------------+
        16
ung 6:85
  Timer:     |
  Hydraulic  |Status:                                                    Status:
  Oil Low    |Oil Press.                                                 Oil Press.
  Pressure   |Fault                                                      Fault Not
  Fault      |Accepted                                                   Accepted
     T4:2          B3                                                       B3
-+---]/[----+---]/[-------------------------------------------------( )----
 |      DN   |      84                                                    36
 |Status:    |
 |Oil Press. |
 |Fault Not  |
 |Accepted   |
 |    B3     |
 +---] [----+
        36
ung 6:86
             |Input:      |Input:
  Status:    |Alarm       |Alarm                                         Status:
  Oil Press. |Accept      |Reset                                         Oil Press.
  Fault Not  |Pushbutton  |Pushbutton                                    Fault
  Accepted   |            |                                              Accepted
      B3         I:013        I:013                                        B3
-+---] [--------] [----+---]/[-------------------------------------------( )----
 |      36          14  |      15                                          84
 |Status:               |
 |Oil Press.            |
 |Fault                 |
 |Accepted              |
 |    B3                |
 +---] [----------------+
        84
```

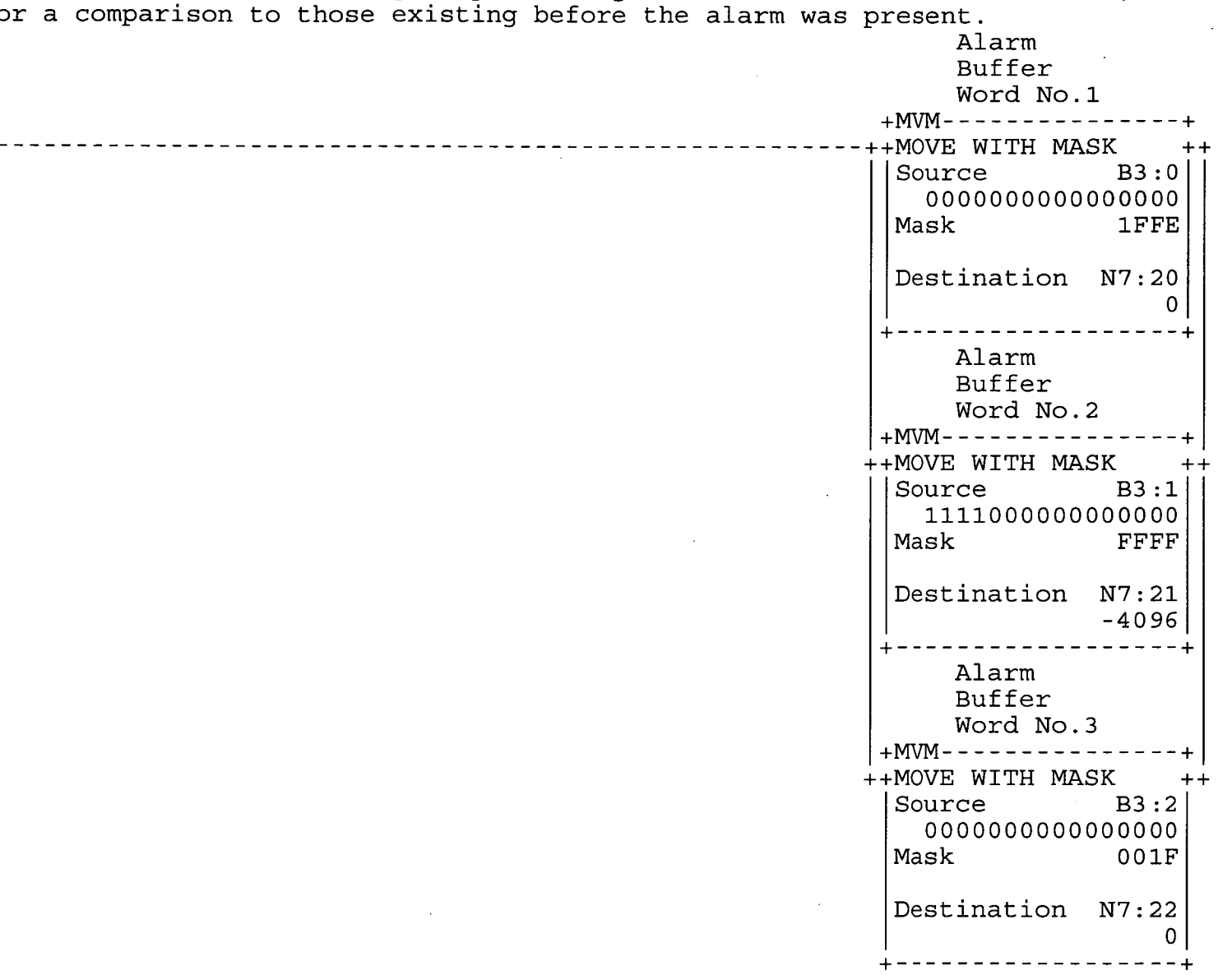
ung 6:87



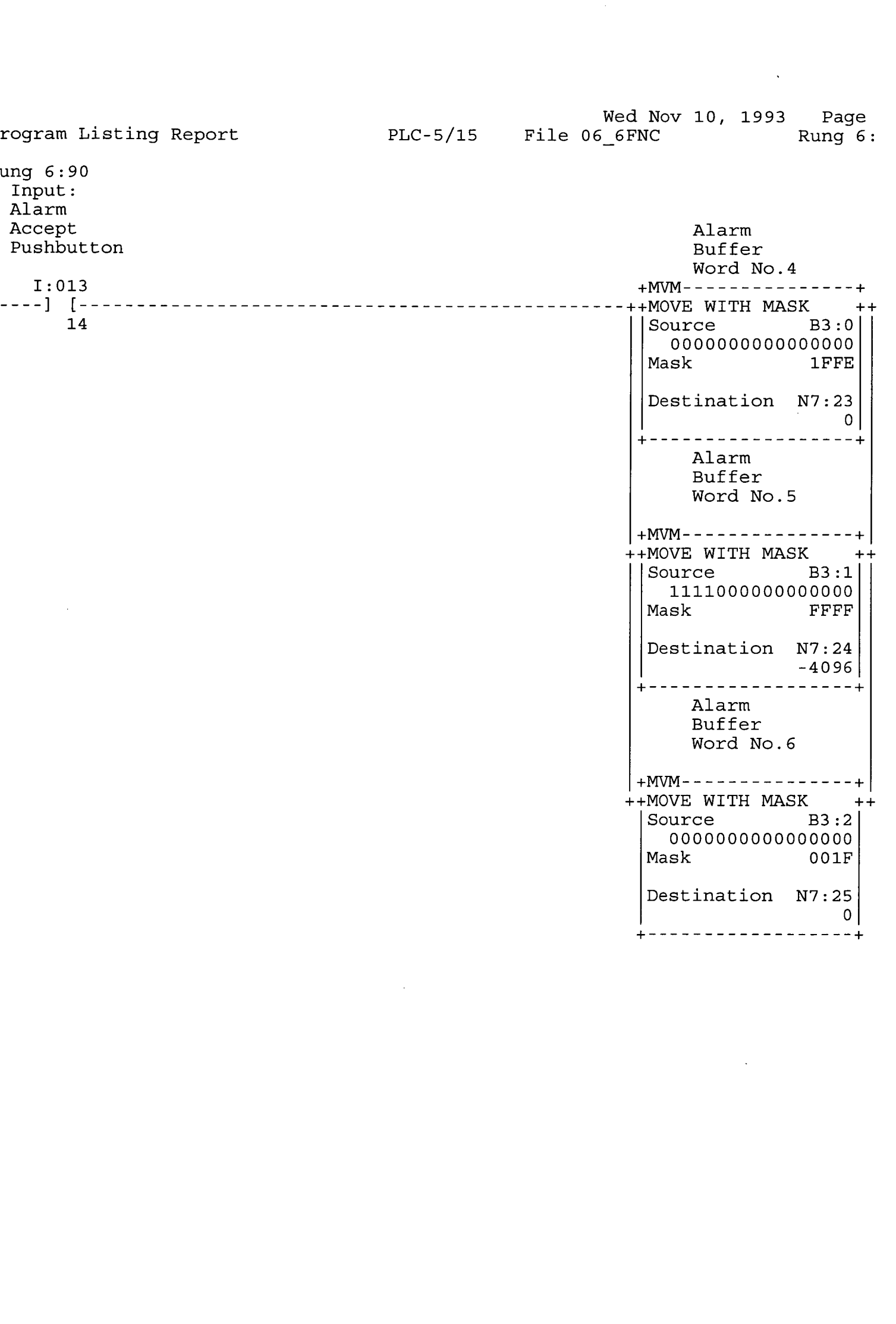
ung 6:88



ung 6:89
his rung is used to arrange any existing alarms into Alarm buffer Words, read
or a comparison to those existing before the alarm was present.



ung 6:90
Input:
Alarm
Accept
Pushbutton



ung 6:91

```
       Alarm                                                    Output:
       Buffer                                                   Alarm
       Word No.1                                                Horn
  +NEQ---------------+                                          O:021
-++NOT EQUAL          ++-----------------------------------------( )----
 ||Source A     N7:20 ||                                          14
 ||                 0 ||
 ||Source B     N7:23 ||
 ||                 0 ||
 |+------------------+|
 |     Alarm          |
 |     Buffer         |
 |     Word No.2      |
 |+NEQ---------------+|
 ++NOT EQUAL          ++
 ||Source A     N7:21 ||
 ||               -4096||
 ||Source B     N7:24 ||
 ||               -4096||
 |+------------------+|
 |     Alarm          |
 |     Buffer         |
 |     Word No.3      |
 |+NEQ---------------+|
 ++NOT EQUAL          ++
  |Source A     N7:22 |
  |                 0 |
  |Source B     N7:25 |
  |                 0 |
  +------------------+
ung 6:92
```

[END OF FILE]

ung 7:0

```
 BTR          |BTW                                          Blk Trans.
 ANA. INPUT   |ANA. INPUT                                   Read
 RACK 0       |RACK 0                                       Instruct.
 MOD.0        |MOD.0                                        for Analog
 ENABLED      |ENABLED                                      In Module
    N9:0        N9:50                          +BTR--------------------+
----]/[--------]/[-------------------------------+BLOCK TRANSFER READ    +-(EN)
      15           15                           |Rack                  00|
                                                |Group                  0+-(DN)
                                                |Module                 0|
                                                |Control block       N9:0+-(ER)
                                                |Data file         N7:100|
                                                |Length                 0|
                                                |Continuous             N|
                                                +------------------------+
```

ung 7:1

```
 BTR          |BTW                                          Blk Trans.
 ANA. INPUT   |ANA. INPUT                                   Write
 RACK 0       |RACK 0                                       To Analog
 MOD.0        |MOD.0                                        Input Mod.
 ENABLED      |ENABLED
    N9:0        N9:50                          +BTW--------------------+
----]/[--------]/[-------------------------------+BLOCK TRANSFER WRITE   +-(EN)
      15           15                           |Rack                  00|
                                                |Group                  0+-(DN)
                                                |Module                 0|
                                                |Control block      N9:50+-(ER)
                                                |Data file         N7:150|
                                                |Length                 0|
                                                |Continuous             N|
                                                +------------------------+
```

ung 7:2

```
 BTR          |BTW                                          Blk Trans.
 ANA.OUTPUT   |ANA.OUTPUT                                   Read for
 RACK 0       |RACK 0                                       Analog
 MOD. 1       |MOD.1                                        Output
 ENABLED      |ENABLED                                      Module
   N9:100       N9:150                          +BTR--------------------+
----]/[--------]/[-------------------------------+BLOCK TRANSFER READ    +-(EN)
      15           15                           |Rack                  00|
                                                |Group                  1+-(DN)
                                                |Module                 0|
                                                |Control block     N9:100+-(ER)
                                                |Data file         N7:200|
                                                |Length                 0|
                                                |Continuous             N|
                                                +------------------------+
```

ung 7:3

```
BTR          |BTW                                                  Blk Trans.
ANA.OUTPUT   |ANA.OUTPUT                                           Write to
RACK 0       |RACK 0                                               Analog
MOD. 1       |MOD.1                                                Output
ENABLED      |ENABLED                                              Module
  N9:100       N9:150                                 +BTW--------------------+
----]/[--------]/[-------------------------------+BLOCK TRANSFER WRITE   +-(EN)
    15           15                               |Rack                  00|
                                                  |Group                  1+-(DN)
                                                  |Module                 0|
                                                  |Control block    N9:150+-(ER)
                                                  |Data file        N7:250|
                                                  |Length                 0|
                                                  |Continuous             N|
                                                  +------------------------+
```

ung 7:4

[END OF FILE]

ung 8:0

Input: No.1 Ingot Station Selected	Input:No.6 Automatic Tilt Select At No.1 M/C	Input:No.7 Automatic Level Select At No.1 M/C	Status: Manual Control Selected No.1
I:027 05	XIO I:027 07	I:027 10	B3 140 (L)

ung 8:1

Input: No.1 Ingot Station Selected	Input:No.6 Automatic Tilt Select At No.1 M/C	Status: Manual Control Selected No.1
I:027 05	XIO I:027 07	B3 140 (U)
Input: No.2 Ingot Station Selected I:027 06		

ung 8:2

Input: No.2 Ingot Station Selected	Input: Manual Tilt No.6 Select At No.2 M/C	Status: Manual Control Selected No.2
I:027 06	I:027 13	B3 141 (L)

ung 8:3

Input: No.2 Ingot Station Selected	Input: Automatic Tilt No.6 Select At No.2 M/C	Status: Manual Control Selected No.2
I:027 06	I:027 14	B3 141 (U)
Input: No.1 Ingot Station Selected I:027 05		

ung 8:4

```
  Status:                                                          Status:
  Manual                                                           Manual
  Control                                                          Control
  Selected                                                         Selected
  No.1                                                             Aux. Relay
       B3                                                              B3
-+---] [----+-------------------------------------------------------( )----
 |     140   |                                                        142
 |Status:    |
 |Manual     |
 |Control    |
 |Selected   |
 |No.2       |
 |     B3    |
 +---] [----+
       141
```

ung 8:5

his rung is used to move the calculated PID control output to the applicable nalogue output control area

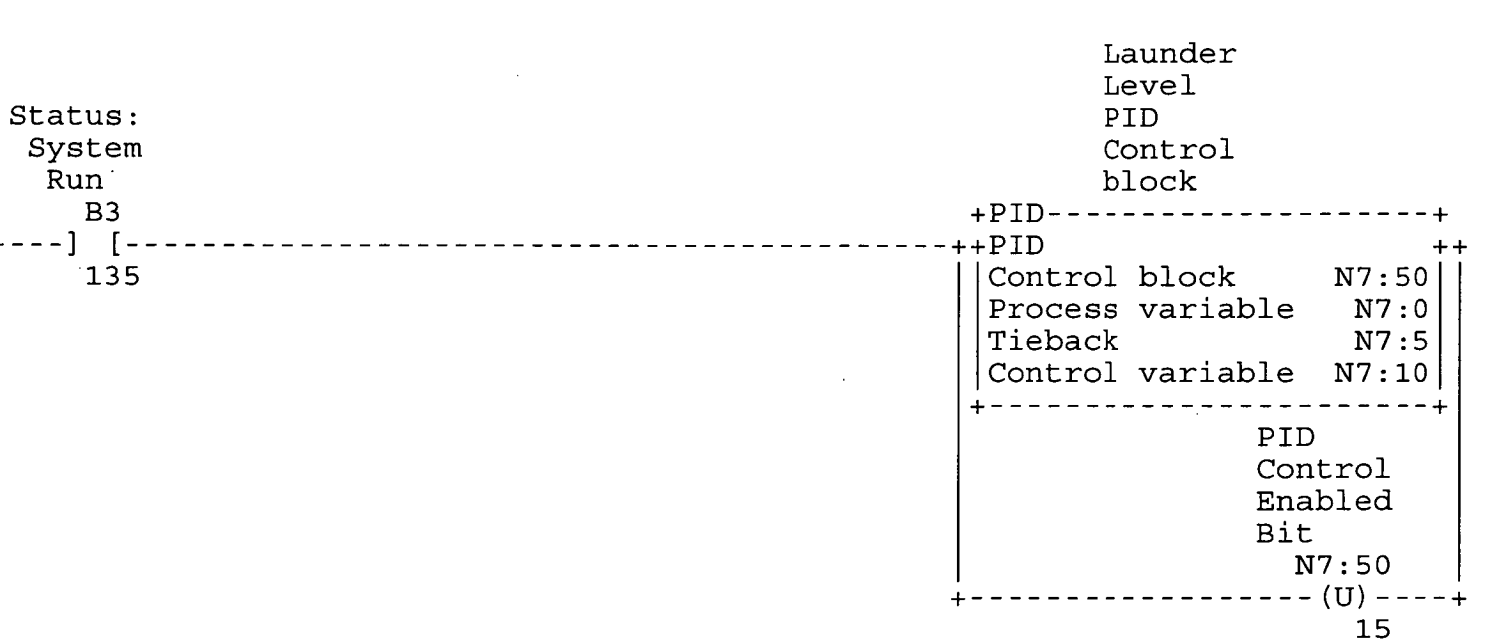
```
 Status:
 Manual                                                            Analogue
 Control                                                           output
 Selected                                                          Channel 1
 Aux. Relay
      B3                                                  +MOV---------------+
----] [-------------------------------------------------+MOVE               +
      142                                               |Source       N7:105|
                                                        |                3520|
                                                        |Destination  N7:250|
                                                        |                   0|
                                                        +------------------+
```

ung 8:6

his rung is used to present an Analogue Input from the Launder Level Sensor t he P.I.D. Control Instruction.

```
 Input:No.6|Status:                                               Launder
 Automatic |Manual                                                Level
 Tilt      |Control                                               PID
 Select At |Selected                                              Control
 No.1 M/C  |Aux. Relay                                            block
    XIO
   I:027         B3                                   +MOV---------------+
----] [--------]/[-------------------------------------+MOVE               +
      07         142                                  |Source       N7:104|
                                                      |                4095|
                                                      |Destination    N7:0|
                                                      |                4095|
                                                      +------------------+
```

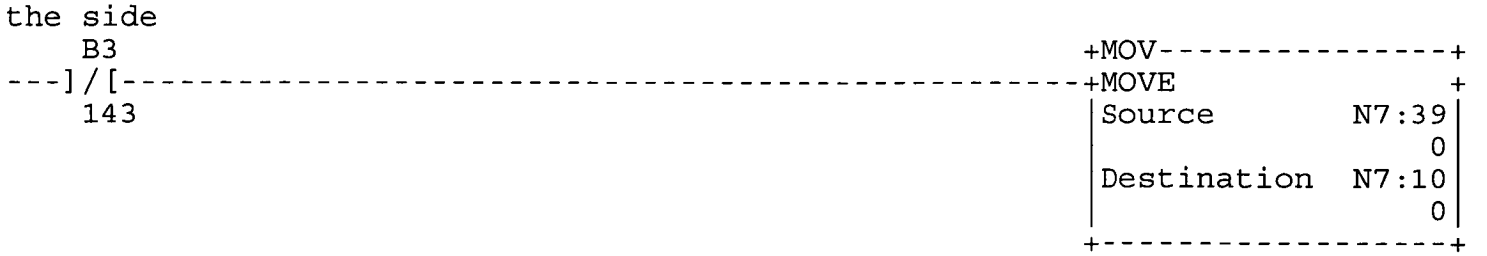
ung 8:7
his rung is used to convert the Launder Level Signal present on
nput No. I;00/00, to a corresponding Output Level used to control
ne "Tilt Rate" of No.6 Furnace.



ung 8:8

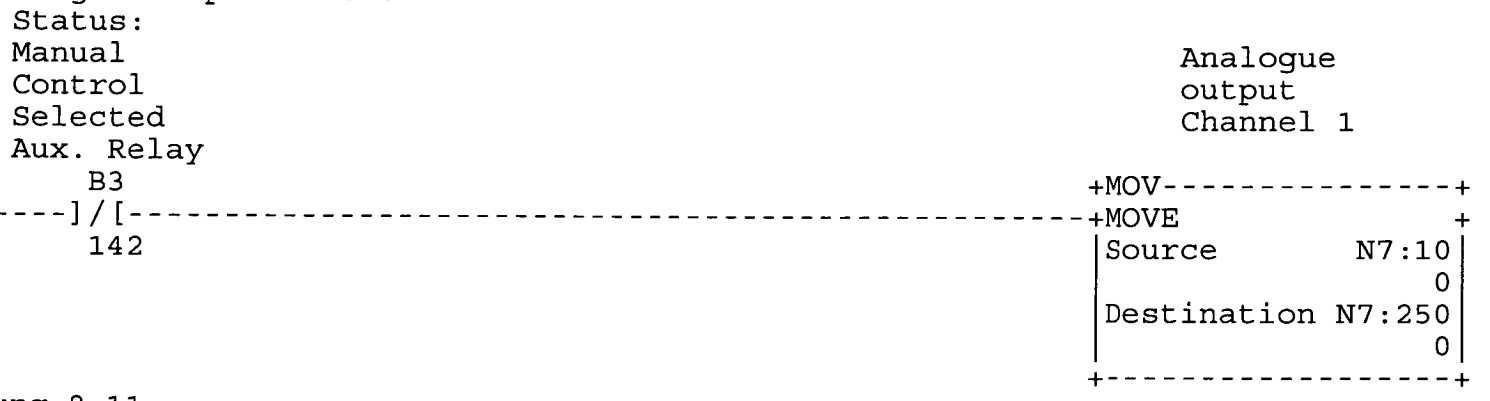
Input:No.6 Automatic Tilt Select At No.1 M/C	Status: Manual Control Selected Aux. Relay	Input: Launder Maximum Metal Level Prox	Input: Launder Minimum Metal Level Prox	Status: System Run	Output: Furnace Raise Solenoid	Spare bit on the side
XIO						
I:027	B3	I:002	I:002	B3	0:020	B3
07	142	00	01	135	13	143

ung 8:9
his rung is used to control the P.I.D." Control Output Word" when the P.I.D.
nstruction has been disabled. It reduces the output signal to Zero to ensure
hat the tilting of the furnace will respond in a predictable manner



ung 8:10

his rung is used to move the calculated PID control output to the applicable
nalogue output control area



ung 8:11

[END OF FILE]

ILE 9 IS NOT TYPE LADDER

ung 10:0

LAUNDER LEVEL CONTROL

```
 Input:                                                                Output:
 Launder                                                               Max. Level
 Maximum                                                               In Launder
 Metal                                                                 Indicator
 Level Prox
   I:002                                                                 O:005
----] [-------------------------------------------------------------------( )----
      00                                                                    01
```

ung 10:1

```
 Input:
 Launder                                                               Output:
 Minimum                                                               Min. Level
 Metal                                                                 In Launder
 Level Prox                                                            Indicator
   I:002                                                                 O:005
----] [-------------------------------------------------------------------( )----
      01                                                                    02
```

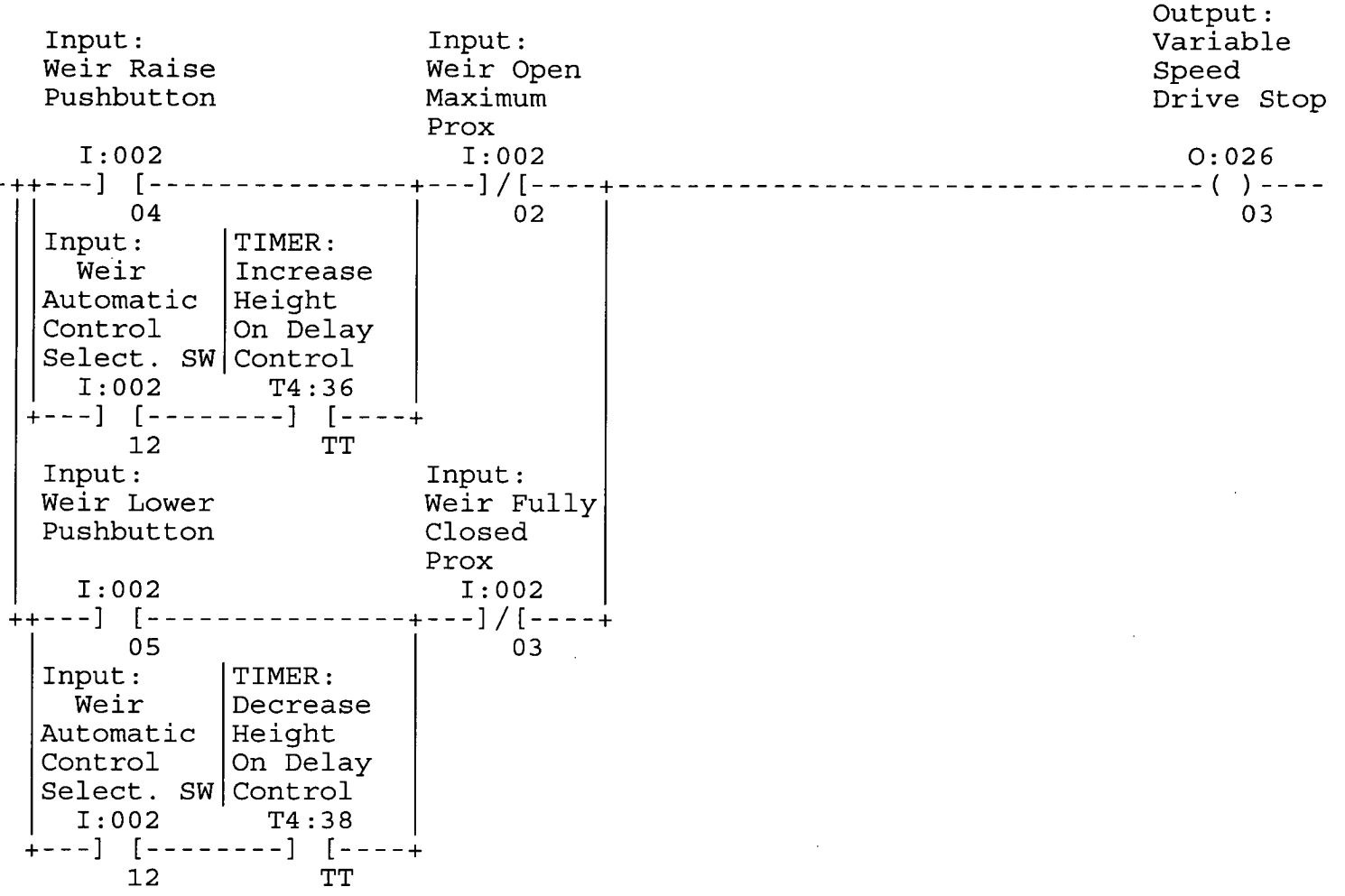
ung 10:2

```
 Input:      |Input:No.6                                               Launder
 Furnace     |Automatic                                                Level in
 Raise Sw.   |Tilt                                                     Automatic
 At No.1     |Select At                                                Control
 Machine     |No.1 M/C                                                 Indicator
                 XIO
   I:012        I:027                                                    O:005
----] [--------] [-------------------------------------------------------( )----
      05          07                                                        00
```

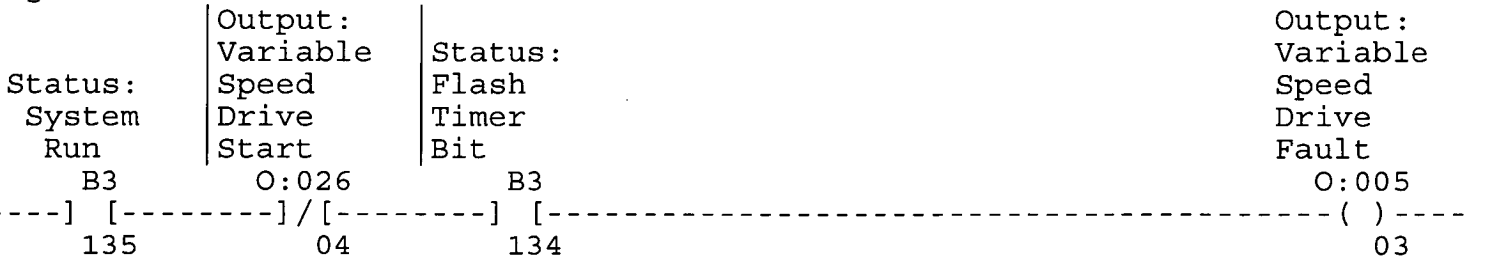
ung 10:3

```
             |Input:                                                   Output:
             |Variable                                                 Variable
 Status:     |Speed                                                    Speed
  System     |Drive                                                    Drive
   Run       |Fault                                                    Start
     B3         I:002                                                    O:026
----] [--------]/[-------------------------------------------------------( )----
     135          11                                                        04
```

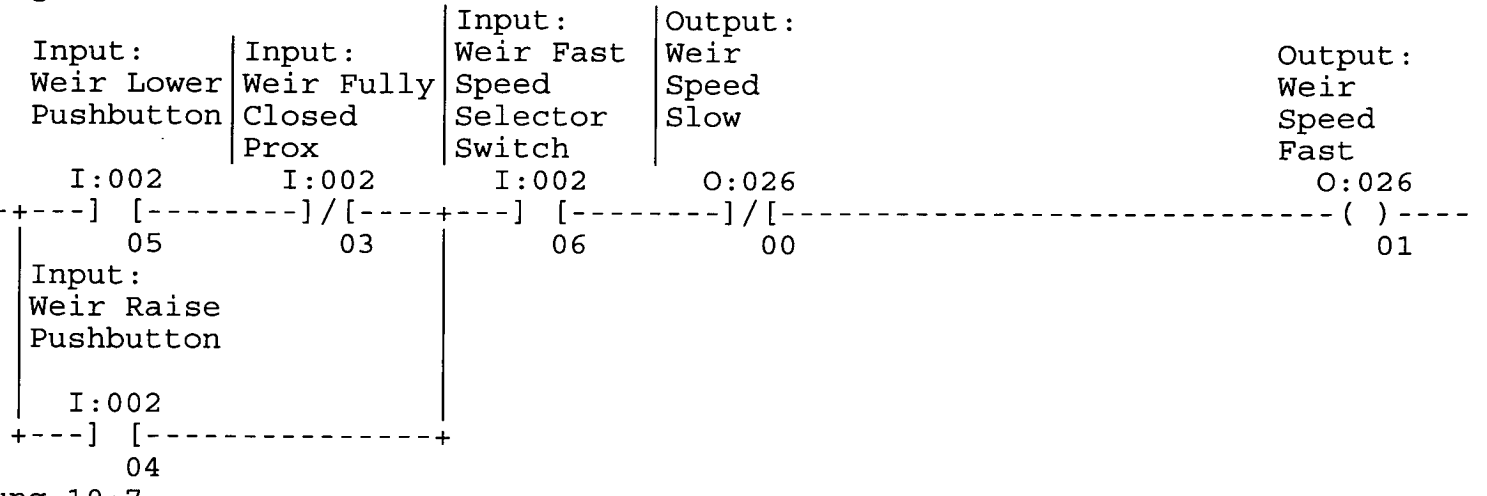
ung 10:4



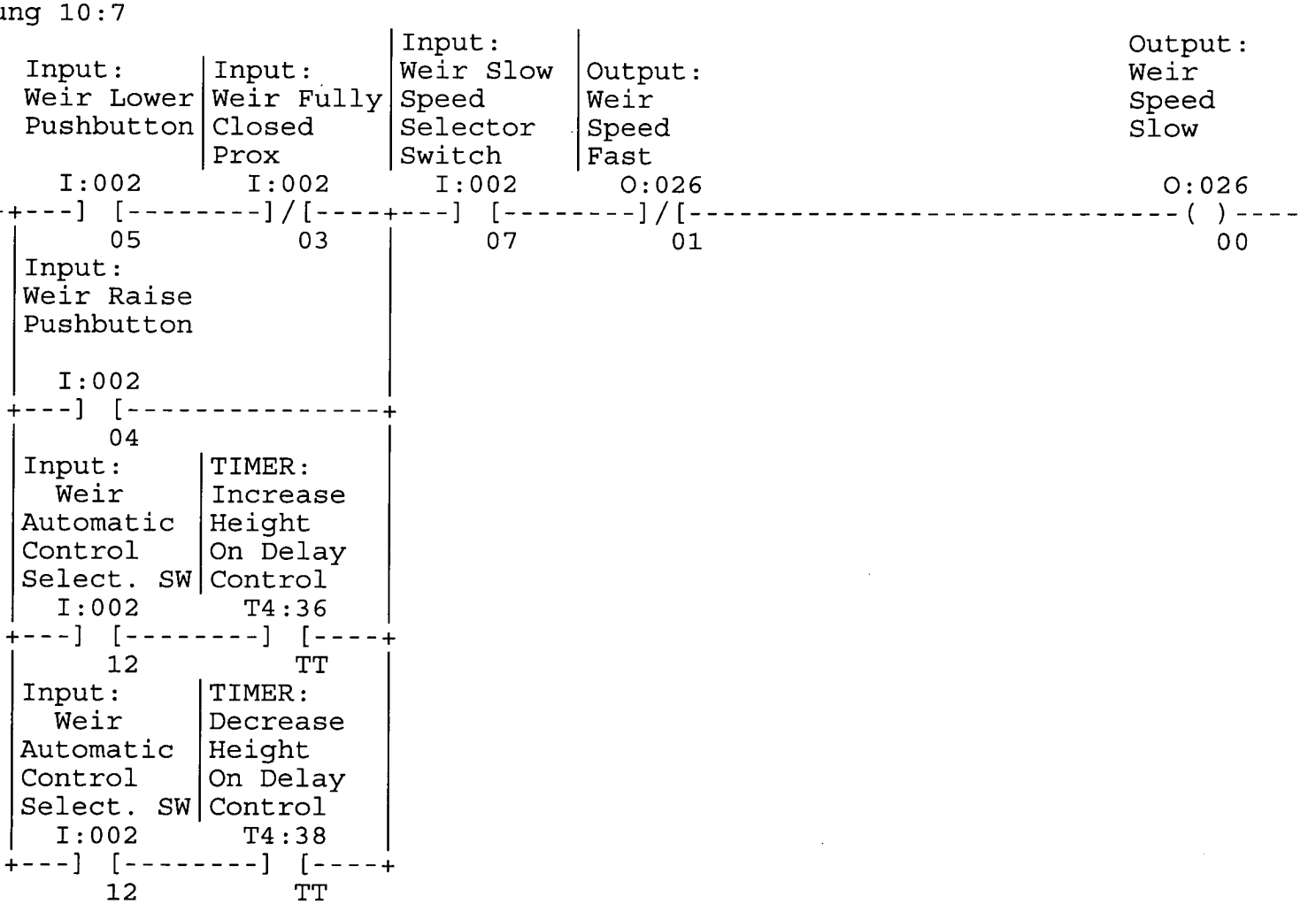
ung 10:5



ung 10:6



ung 10:7



ung 10:8

```
  Input:                    Input:      |Input:                                Output:
  Weir Raise                Weir Open   |Weir Lower                            Weir
  Pushbutton                Maximum     |Pushbutton                            Raise/
                            Prox        |                                      Lower
     I:002                    I:002        I:002                                O:026
-+---] [-----------------+---]/[--------]/[-------------------------------( )----
 |      04               |      02           05                                 02
 |Input:      |STATUS:   |
 |  Weir      |Auto Ingot|
 |Automatic   |Height    |
 |Control     |RAISE WEIR|
 |Select. SW  |CONTROL   |
 |  I:002          B3    |
 +---] [--------] [-----+
        12         183
```

ung 10:9

[END OF FILE]

```
ung 11:0
  Input:      |Input:          Output:                                    Output:
  Cast No.7   | Tap Plug       Tap Plug                                   Tap Plug
  Through     | IN P/B           OUT                                        IN
  No.2 Ingot  | at No.1        Actuator                                   Actuator
  Machine     | Machine
    I:003       I:002          O:005                                      O:005
-+---]/[--------] [--------+---]/[-----------------------------------( )----
 |     03          14      |     14                                       05
 |  Input:      |Input:
 |  Cast No.7   |Tap Plug
 |  Through     |IN P/B
 |  No.2 Ingot  |at No.2
 |  Machine     |Machine
 |    I:003       I:003
 ++---] [--------] [------++
  |      03          01    |
  |  Input:                |
  |    Tap                 |
  |   Plug IN              |
  |   P/B at 7             |
  |   Furnace              |
  |    I:002               |
  ++---] [----------------++
   |      16               |
   |STATUS:     |Timer:    |
   |Automatic   |Decrease  |
   |Level       |Launder   |
   |Control     |Level from|
   |Engage      |No.7 Frnce|
   |    B3        T4:30    |
   +---] [--------] [----+
         184          TT
ung 11:1
 Output:
 Tap Plug                                                                 Output:
    IN                                                                     Tap Plug
  Actuator                                                                   IN
                                                                          Indicator
   O:005                                                                   O:005
----] [-----------------------------------------------------------------( )----
      05                                                                    06
```

```
ung 11:2
  Input:      |Input:      |Output:                                                    Output:
  Cast No.7   |Tap Plug    |Tap Plug                                                   Tap Plug
  Through     |OUT P/B     |   IN                                                      OUT
  No.2 Ingot  |at No.1     | Actuator                                                  Actuator
  Machine     |Machine     |
    I:003       I:002       O:005                                                     O:005
-+---]/[--------] [----+---]/[-----------------------------------------( )----
 |     03          15  |     05                                                      14
 |  Input:     |Input:    |
 |  Cast No.7  |Tap Plug  |
 |  Through    |OUT P/B   |
 |  No.2 Ingot |at No.2   |
 |  Machine    |Machine   |
 |    I:003      I:003    |
 +---] [--------] [----+
 |     03          02  |
 |  Input:             |
 |   Tap Plug          |
 |   OUT P/B           |
 |   at No.7           |
 |   Furnace           |
 |    I:002            |
 +---] [---------------+
 |     17              |
 |  STATUS:    |Timer:    |
 |  Automatic  |Increase  |
 |  Level      |Launder   |
 |  Control    |Level from|
 |  Engage     |No.7 Frnce|
 |     B3        T4:31    |
 +---] [--------] [----+
 |    184          TT  |
 |  Timer              |
 |  Tap Plug           |
 |  Brake              |
 |  Control            |
 |                     |
 |    T4:20            |
 +---] [---------------+
       TT
ung 11:3
 Output:
  Tap Plug                                                                          Output:
    OUT                                                                             Tap Plug
  Actuator                                                                            OUT
                                                                                    Indicator
    O:005                                                                             O:005
----] [-----------------------------------------------------------------------( )----
      14                                                                            07
```

ung 11:4

```
 Input:No.7 | Input:      | STATUS:                                                  STATUS:
 Automatic  | Cast No.7   | Oneshot                                                  Automatic
 Level      | Through     | To Engage                                                Level
 Select At  | No.2 Ingot  | Auto Level                                               Control
 No.1 M/C   | Machine     | Control                                                  Engage
    I:027       I:003          B3                                                      B3
----] [--------]/[-------[ONS]-----------------------------------------------(L)----
       10          03          185                                                    184
```

ung 11:5

```
       Launder
       Level
       Scaled
       Input
       Value                                                    STATUS:
                                                                Automatic
                                                                Level
                                                                Control
                                                                Engage
  +GRT---------------+                                             B3
-++GREATER THAN      ++-------------------------------------------(U)----
 ||Source A    N7:300||                                            184
 ||               1000||
 ||Source B    N7:320||
 ||                800||
 |+------------------+|
 |      Launder       |
 |      Level         |
 |      Scaled        |
 |      Input         |
 |      Value         |
 |+LES---------------+|
 ++LESS THAN         ++
 ||Source A    N7:300||
 ||               1000||
 ||Source B    N7:321||
 ||                100||
 |+------------------+|
 |Input:              |
 |Launder             |
 |Maximum             |
 |Metal               |
 |Level Prox          |
 |  I:002             |
+---] [--------------+|
 |      00            |
 |Input:              |
 |Launder             |
 |Minimum             |
 |Metal               |
 |Level Prox          |
 |  I:002             |
+---] [--------------+|
 |      01            |
 |Input:No.7          |
 |Automatic           |
 |Level               |
 |Select At           |
 |No.1 M/C            |
 |  I:027             |
+---]/[--------------+|
       10
```

ung 11:6
his rung is used to convert the Analogue Signal seen from the Launder Level,
o a number between 0 - 1000. (i.e. Scaling this input as would be done within
he P.I.D.Instruction).
his "Scaled value" is then compared to the resident Launder Level Setpoint
ound and set within the Launder Level Control P.I.D. Instruction, to ensure
imilar Launder Levels are supplied irrespective which Furnace is used.

Launder Level Scaled Input Value

```
                                                    +DIV---------------+
----------------------------------------------------+DIVIDE            +
                                                    |Source A    N7:104|
                                                    |                4095|
                                                    |Source B  4.095000|
                                                    |                  |
                                                    |Destination N7:300|
                                                    |                1000|
                                                    +------------------+
```

ung 11:7

Launder Level Upper Control Limit

```
                                                    +ADD---------------+
----------------------------------------------------+ADD               +
                                                    |Source A    N7:306|
                                                    |                 475|
                                                    |Source B    N7:307|
                                                    |                  75|
                                                    |Destination N7:308|
                                                    |                 550|
                                                    +------------------+
```

ung 11:8
his rung is used to allow an "Upper Control Deadband Limit" to be set. This
to reduce the effects of Launder level "Hunting".

Change the Upper Limit: Vary the value set in Data Table Address N7:305.

Launder Level Deadband Upper Limit

```
                                                    +ADD---------------+
----------------------------------------------------+ADD               +
                                                    |Source A     N7:52|
                                                    |                 500|
                                                    |Source B    N7:305|
                                                    |                 -25|
                                                    |Destination N7:306|
                                                    |                 475|
                                                    +------------------+
```

ung 11:9
his rung is used to Set a "Lower Control Deadband Limit". It is used in
onjunction with the rung above to reduce any "Hunting" in the Launder Level.

o Change the Lower Limit: Vary the value Set in Data Table Address N7:304

Launder Level Deadband Lower Limit

```
+SUB---------------+
+SUBTRACT           +
|Source A     N7:52|
|                500|
|Source B    N7:304|
|                 -5|
|Destination N7:303|
|                505|
+------------------+
```

ung 11:10

Launder Level Lower Control Limit

```
+SUB---------------+
+SUBTRACT           +
|Source A    N7:303|
|                505|
|Source B    N7:302|
|                375|
|Destination N7:301|
|                130|
+------------------+
```

ung 11:11

Launder Level Scaled Input Value

```
 +GRT---------------+
-+GREATER THAN      +-
 |Source A    N7:300|
 |                1000|
 |Source B    N7:306|
 |                 475|
 +------------------+
```

Launder Level Scaled Input Value

```
 +LIM---------------+
-+LIMIT TEST (CIRC) +-
 |Low limit   N7:306|
 |                 475|
 |Test        N7:300|
 |                1000|
 |High limit  N7:308|
 |                 550|
 +------------------+
```

STATUS: Slow Movement Control (Hi Side) B3

```
-----------------------------( )----
                               176
```

ung 11:12

Launder Level Scaled Input Value

+LES- +LIM-

-+LESS THAN +-+LIMIT TEST (CIRC) +-( )-

Source A N7:300		Low limit N7:301
1000		130
Source B N7:303		Test N7:300
505		1000
		High limit N7:303
		505

STATUS: Slow Movement Control (Lo Side) B3 177

ung 11:13

STATUS: Slow Movement Control (Hi Side) B3 176

Timer: Decrease Launder Level Control

+MOV-

+MOVE +

| Source N7:310 |
| 100 |
| Destination T4:30.PRE |
| 200 |

ung 11:14

STATUS: Slow Movement Control (Hi Side) B3 176

Timer: Decrease Launder Level Control

+MOV-

+MOVE +

| Source N7:311 |
| 200 |
| Destination T4:30.PRE |
| 200 |

ung 11:15

STATUS: Slow Movement Control (Lo Side) B3 177

TIMER: Increase Launder Level Control

+MOV-

+MOVE +

| Source N7:312 |
| 125 |
| Destination T4:31.PRE |
| 175 |

ung 11:16
STATUS:
Slow
Movement
Control
(Lo Side)

B3
---]/[---
177

TIMER:
Increase
Launder
Level
Control

+MOV---------+
+MOVE +
|Source N7:313|
| 175|
|Destination T4:31.PRE|
| 175|
+-----------+

ung 11:17
Timer:
Decrease
Launder
Level from
No.7 Frnce

T4:30
+---] [----+
| DN |
|Timer: |
|Decrease |
|Level |
|Control |
|Off |
| T4:29 |
+---] [----+
TT

Timer:
Decrease
Level
Control
Off

+TON---------+
+TIMER ON DELAY +-(EN)
|Timer T4:29|
|Time base 0.01+-(DN)
|Preset 2000|
|Accum 0|
+-----------+

ung 11:18
the Level is above the Setpoint Deadband Upper Limit, the Furnace Tap Plug
s controlled to reduce the flow of metal. This controlling is done using the
On" time of this timer. To alter this change the preset value in this timer.

STATUS:
Automatic
Level
Control
Engage

B3
---] [-----
184

Launder
Level
Scaled
Input
Value

+GEQ---------+
+GREATER THAN OR EQUAL +
|Source A N7:300|
| 1000|
|Source B N7:306|
| 475|
+-----------+

Timer:
Decrease
Level
Control
Off

T4:29
----]/[----
TT

|Timer:
|Decrease
|Launder
|Level from
|No.7 Frnce

T4:30
----]/[----
DN

|Timer:
|Increase
|Launder
|Level from
|No.7 Frnce

T4:31
----]/[----
TT

```
Timer                Timer:                  |
Tap Plug             Decrease                |
Brake                Launder                 |
Control              Level from              |
                     No.7 Frnce              |
  T4:20     +TON---------------+              |
---]/[-----+TIMER ON DELAY     +-(EN)-+       |
     TT    |Timer          T4:30|    |       |
           |Time base       0.01+-(DN)|      |
           |Preset           200|    |       |
           |Accum              0|    |       |
           +--------------------+    |       |
```

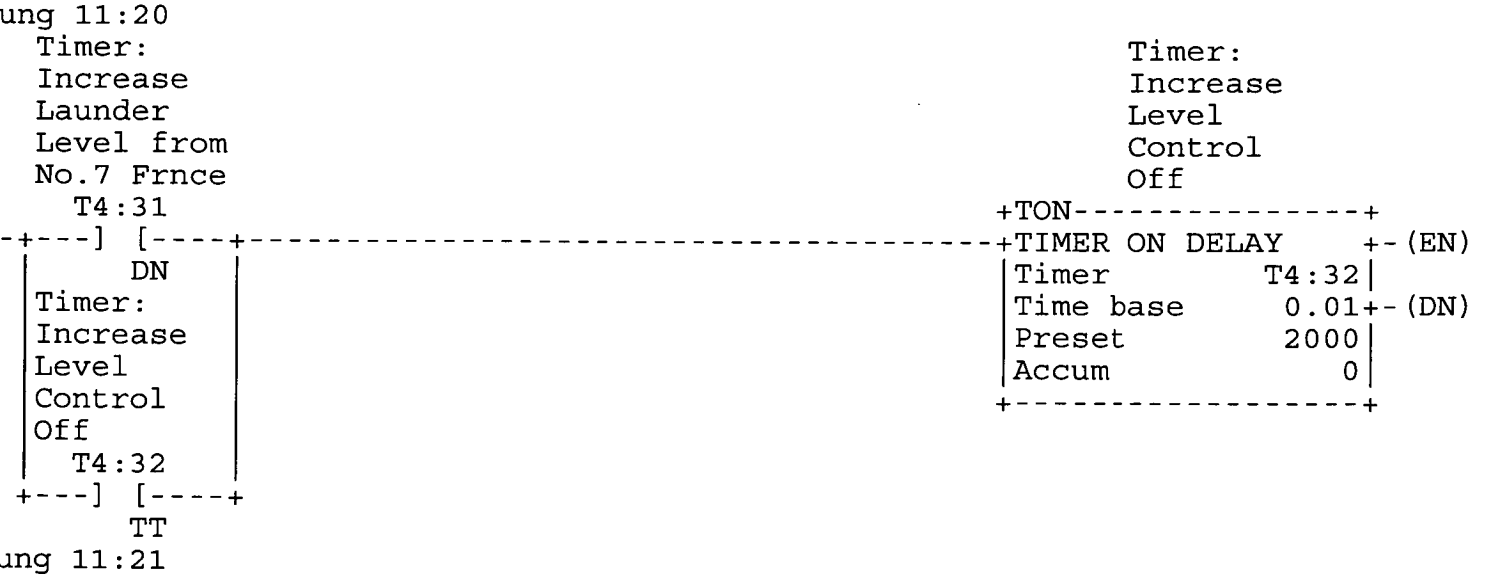
ung 11:19
his rung is used to Increase the flow of metal when the Launder Level is less
han the Setpoint Lower Deadband Limit.

o alter this change the preset value of this timer.

```
STATUS:          Launder          Timer:     |Timer:     |Timer:
Automatic        Level            Increase   |Increase   |Decrease
Level            Scaled           Level      |Launder    |Launder
Control          Input            Control    |Level from |Level from
Engage           Value            Off        |No.7 Frnce |No.7 Frnce
    B3      +LEQ---------------+    T4:32       T4:31       T4:30
---] [-----+LESS THAN OR EQUAL+----]/[--------]/[--------]/[----------------
    184     |Source A    N7:300|       TT          DN          TT
            |                1000|
            |Source B    N7:303|
            |                 505|
            +-------------------+
```

```
      Timer:                  |
      Increase                |
      Launder                 |
      Level from              |
      No.7 Frnce              |
-TON---------------+          |
-TIMER ON DELAY    +-(EN)-+   |
-Timer         T4:31|     |   |
-Time base      0.01+-(DN)|   |
-Preset          175|     |   |
-Accum              0|     |   |
------------------+          |
```

ung 11:20



ung 11:21

[END OF FILE]

ung 12:0

Input: Sensor at Ingot Mold Leading Edge — I:003 06

STATUS: Oneshot At Leading Edge of Mold — B3 178

Ingot Mould Edge Height Buffer

MOV MOVE
Source N7:107 4080
Destination N7:340 4046

ung 12:1

Input: Sensor at Ingot Mold Centre — I:003 05

STATUS: Oneshot Sensor at Centre of Mold — B3 179

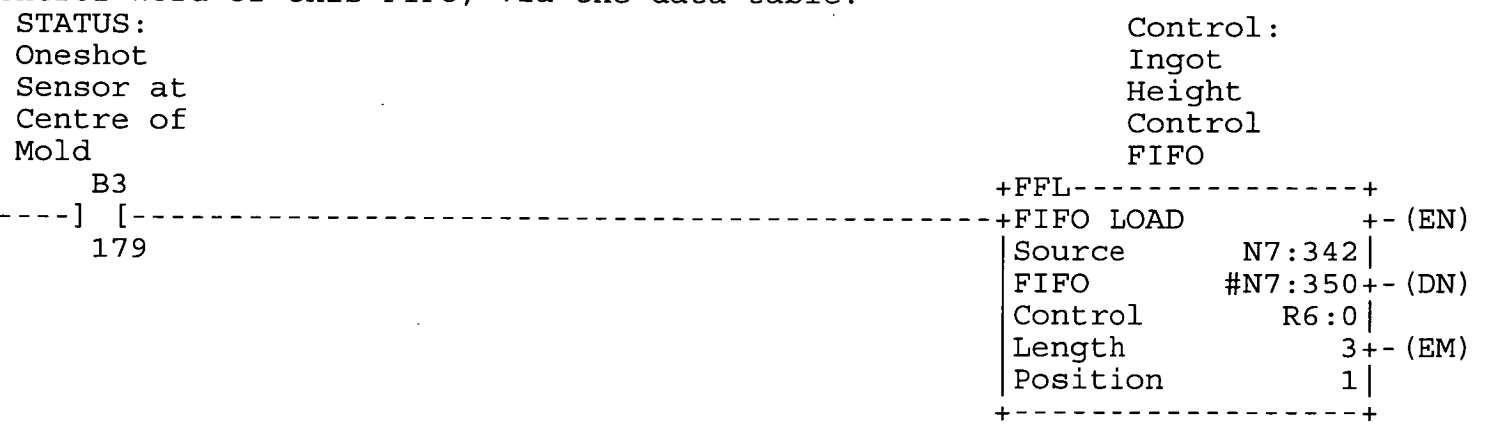
Ingot Height in Mould Buffer

MOV MOVE
Source N7:107 4080
Destination N7:341 3751

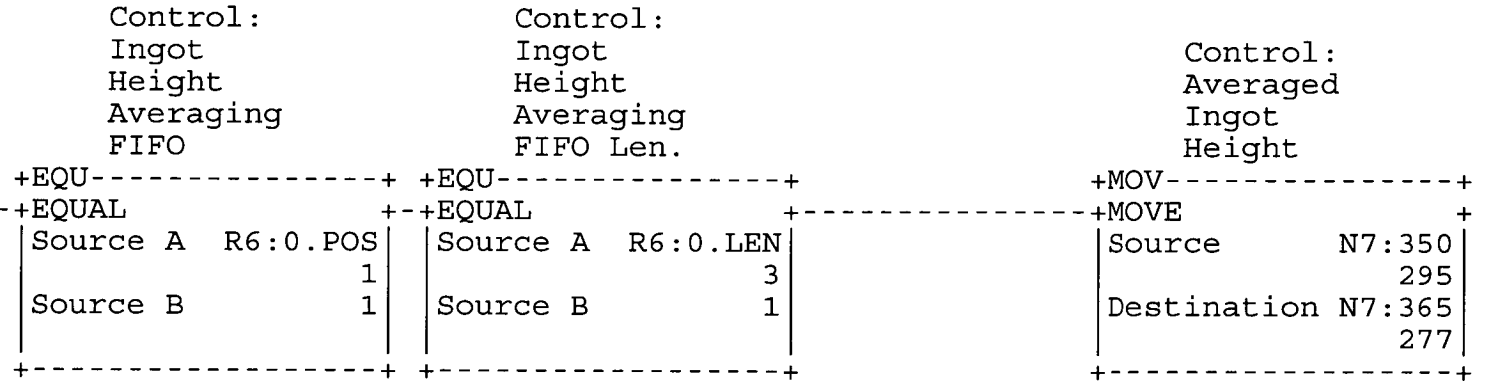
Difference between Ingot & Mould Buffer

SUB SUBTRACT
Source A N7:340 4046
Source B N7:341 3751
Destination N7:342 295

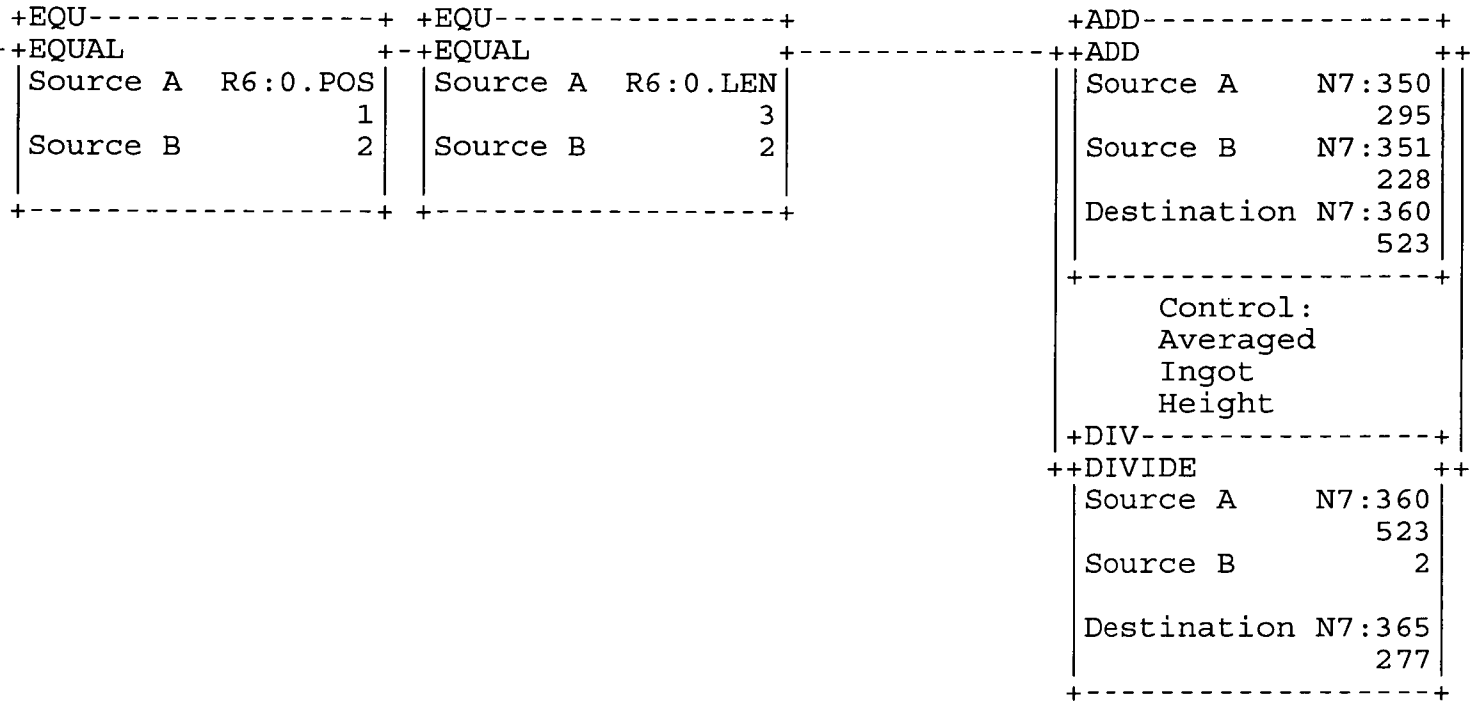
ung 12:2
his rung is used to "stack" the number of values from the Ingot Sensor.
o modify the reaction time of the system, alter the "length" within the
ontrol Word of this FIFO, via the data table.



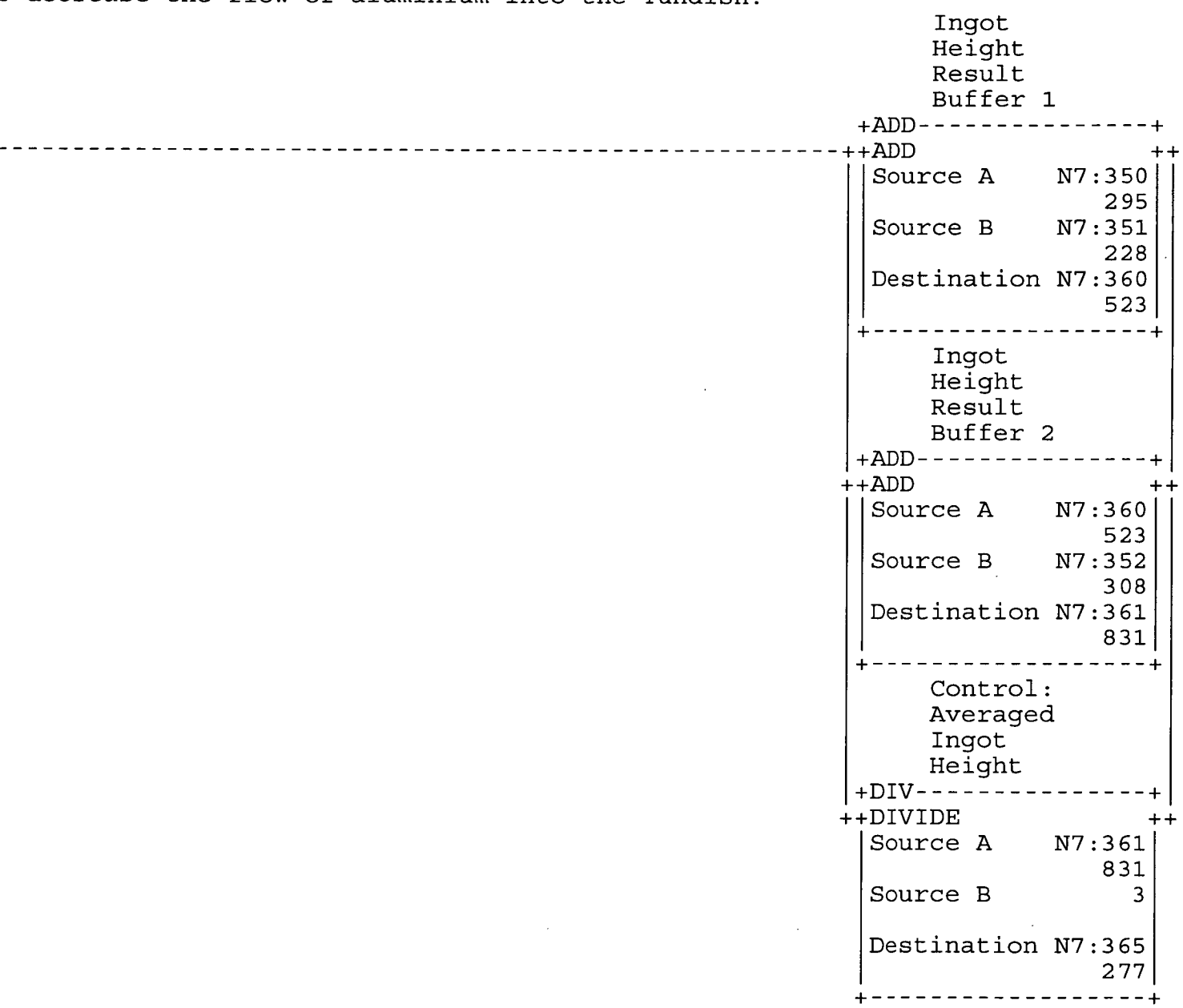
ung 12:3



ung 12:4
his rung is used to average the ingot depths, this is stored for use to
etermine whether there is to be a resulting action from the Weir to increase
r decrease the flow of aluminium into the Tundish.



ung 12:5
his rung is used to average the ingot depths, this is stored for use to
etermine whether there is to be a resulting action from the Weir to increase
r decrease the flow of aluminium into the Tundish.



ung 12:6
his rung is used to reset the FIFO after the stack is filled.

Control:
Ingot
Height
Averaging
FIFO Len.

```
 +EQU---------------+                          +MOV--------------------+
-+EQUAL              +--------------------------+MOVE                   +
 |Source A  R6:0.LEN|                          |Source               0|
 |                 3|                          |                      |
 |Source B  R6:0.POS|                          |Destination    R6:0.POS|
 |                 1|                          |                      1|
 +------------------+                          +----------------------+
```

Control:
Ingot
Height
Averaging
FIFO

ung 12:7
he following rungs are use to control the Deadband and Control Limits used by he Ingot Height Control system. To alter the Ingot height, modify the current alue located within the Data File; N7:400.

Ingot
Height
S/point
Hi Side
Deadband

```
                                                    +ADD---------------+
----------------------------------------------------+ADD                +
                                                    |Source A    N7:400|
                                                    |                170|
                                                    |Source B    N7:401|
                                                    |                -30|
                                                    |Destination N7:402|
                                                    |                140|
                                                    +------------------+
```

ung 12:8

Ingot
Height
Long/Short
Pulse
Hi Limit

```
                                                    +ADD---------------+
----------------------------------------------------+ADD                +
                                                    |Source A    N7:402|
                                                    |                140|
                                                    |Source B    N7:403|
                                                    |                -30|
                                                    |Destination N7:404|
                                                    |                110|
                                                    +------------------+
```

ung 12:9

```
                                                    Ingot
                                                    Height
                                                    Lo S/point
                                                    Deadband
                                                    Control
                                                  +SUB---------------+
------------------------------------------------------+SUBTRACT          +
                                                  |Source A    N7:400|
                                                  |                170|
                                                  |Source B    N7:405|
                                                  |                -30|
                                                  |Destination N7:406|
                                                  |                200|
                                                  +------------------+
```

ung 12:10

```
                                                    Ingot
                                                    Height
                                                    Long/Short
                                                    Pulse
                                                    Lo Limit
                                                  +SUB---------------+
------------------------------------------------------+SUBTRACT          +
                                                  |Source A    N7:406|
                                                  |                200|
                                                  |Source B    N7:407|
                                                  |                -30|
                                                  |Destination N7:408|
                                                  |                230|
                                                  +------------------+
```

ung 12:11

```
      Control:                Control:                                STATUS:
      Averaged                Averaged                                Lower Weir
      Ingot                   Ingot                                   Short
      Height                  Height                                  Pulse
                                                                      Control
                                                                          B3
 +LES---------------+ +LIM---------------+                          ( )----
-+LESS THAN         +-+LIMIT TEST (CIRC) +-----------------------------  180
 |Source A    N7:365| |Low limit   N7:402|
 |                277| |                140|
 |Source B    N7:402| |Test        N7:365|
 |                140| |                277|
 +------------------+ |High limit  N7:404|
                      |                110|
                      +------------------+
```

ung 12:12

Control: Averaged Ingot Height

+LES
+LESS THAN
Source A N7:365 277
Source B N7:402 140

STATUS: Auto Ingot Height Control LOWER WEIR B3 182

ung 12:13

Control: Averaged Ingot Height

+GRT
+GREATER THAN
Source A N7:365 277
Source B N7:406 200

Control: Averaged Ingot Height

+LIM
+LIMIT TEST (CIRC)
Low limit N7:406 200
Test N7:365 277
High limit N7:408 230

STATUS: Raise Weir Short Pulse Control B3 181

ung 12:14

Control: Averaged Ingot Height

+GRT
+GREATER THAN
Source A N7:365 277
Source B N7:406 200

STATUS: Auto Ingot Height RAISE WEIR CONTROL B3 183

ung 12:15

STATUS: Raise Weir Short Pulse Control B3 181

STATUS: Auto Ingot Height RAISE WEIR CONTROL B3 183

TIMER: Increase Height Control Preset

+MOV
+MOVE
Source N7:410 12
Destination T4:36.PRE 14

ung 12:16

```
 STATUS:    |STATUS:                                          TIMER:
 Raise Weir |Auto Ingot                                      Increase
 Short      |Height                                          Height
 Pulse      |RAISE WEIR                                      Control
 Control    |CONTROL                                         Preset
     B3          B3                                    +MOV--------------------+
----]/[--------] [-----------------------------------+MOVE                     +
     181         183                                  |Source            N7:411|
                                                      |                       14|
                                                      |Destination    T4:36.PRE|
                                                      |                       14|
                                                      +-------------------------+
```

ung 12:17

```
 STATUS:    |STATUS:                                          TIMER:
 Lower Weir |Auto Ingot                                      Decrease
 Short      |Height                                          Height
 Pulse      |Control                                         Control
 Control    |LOWER WEIR                                      Preset
     B3          B3                                    +MOV--------------------+
----] [--------] [-----------------------------------+MOVE                     +
     180         182                                  |Source            N7:412|
                                                      |                       12|
                                                      |Destination    T4:38.PRE|
                                                      |                       12|
                                                      +-------------------------+
```

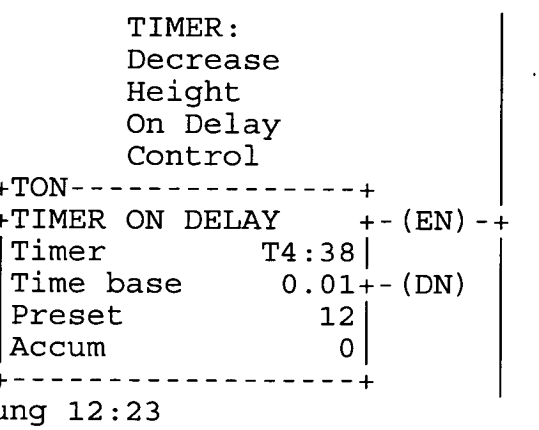
ung 12:18

```
 STATUS:    |STATUS:                                          TIMER:
 Lower Weir |Auto Ingot                                      Decrease
 Short      |Height                                          Height
 Pulse      |Control                                         Control
 Control    |LOWER WEIR                                      Preset
     B3          B3                                    +MOV--------------------+
----]/[--------] [-----------------------------------+MOVE                     +
     180         182                                  |Source            N7:413|
                                                      |                       14|
                                                      |Destination    T4:38.PRE|
                                                      |                       12|
                                                      +-------------------------+
```

ung 12:19

```
  TIMER:                                                TIMER:
  Increase                                              Increase
  Height                                                Ingot Hght
  Off Delay                                             Level
  Control                                               Off Delay
    T4:36                                           +TON--------------+
+---] [----+-------------------------------------+TIMER ON DELAY    +-(EN)
|      DN   |                                     |Timer         T4:35|
|TIMER:     |                                     |Time base       1.0+-(DN)
|Increase   |                                     |Preset           50|
|Ingot Hght |                                     |Accum             0|
|Level      |                                     +------------------+
|Off Delay  |
|  T4:35    |
+---] [----+
      TT
```

```
ung 12:20
 Input:                                          TIMER:     |TIMER:     |TIMER:
   Weir              Control:                    Increase   |Decrease   |Decrease
 Automatic           Averaged                    Ingot Hght |Height     |Height
 Control             Ingot                       Level      |Off Delay  |On Delay
 Select. SW          Height                      Off Delay  |Control    |Control
   I:002     +GEQ--------------------+   T4:35       T4:37       T4:38
----] [-----+GREATER THAN OR EQUAL  +----]/[--------]/[--------]/[-----------
      12     |Source A          N7:365|      TT          TT          TT
             |                     277|
             |Source B          N7:406|
             |                     200|
             +------------------------+

       TIMER:                  |
       Increase                |
       Ingot Hght              |
       On Delay                |
       Timer                   |
+TON---------------+           |
+TIMER ON DELAY    +-(EN)-+    |
|Timer        T4:36|         |
|Time base     0.01+-(DN)  |
|Preset          14|         |
|Accum            0|         |
+------------------+         |
ung 12:21
  TIMER:                                                    TIMER:
  Decrease                                                  Decrease
  Height                                                    Height
  On Delay                                                  Off Delay
  Control                                                   Control
    T4:38                                                +TON---------------+
-+---] [----+-----------------------------------------+TIMER ON DELAY     +-(EN)
 |      DN   |                                         |Timer         T4:37|
 |TIMER:     |                                         |Time base       1.0+-(DN)
 |Decrease   |                                         |Preset           55|
 |Height     |                                         |Accum             0|
 |Off Delay  |                                         +------------------+
 |Control    |
 |  T4:37    |
 +---] [----+
       TT
ung 12:22
 Input:                                          TIMER:     |TIMER:     |TIMER:
   Weir              Control:                    Decrease   |Increase   |Increase
 Automatic           Averaged                    Height     |Ingot Hght |Height
 Control             Ingot                       Off Delay  |Level      |On Delay
 Select. SW          Height                      Control    |Off Delay  |Control
   I:002     +LEQ---------------+   T4:37       T4:35       T4:36
----] [-----+LESS THAN OR EQUAL+----]/[--------]/[--------]/[---------------
      12     |Source A    N7:365|      TT          TT          TT
             |                 277|
             |Source B    N7:402|
             |                 140|
             +-------------------+
```


TIMER:
Decrease
Height
On Delay
Control
+TON----------+
+TIMER ON DELAY +-(EN)-+
|Timer T4:38|
|Time base 0.01+-(DN)
|Preset 12|
|Accum 0|
+----------+
ung 12:23

[END OF FILE]

ung 13:0
he maximum value for ingot height as read by the ingot sensor is 2070, the alue of the actual ingot height is subtracted from it to obtain the actual ngot height. The scale of 0-2070 corresponds to 0-100%.

Citect: Averaged Ingot Height

```
                                                          +SUB---------------+
----------------------------------------------------------+SUBTRACT          +
                                                          |Source A    N7:415|
                                                          |                2070|
                                                          |Source B    N7:365|
                                                          |                 277|
                                                          |Destination  N7:30|
                                                          |                1793|
                                                          +------------------+
```

ung 13:1
rom the actual ingot height obtained above the trends on Citect are too ompressed, to improve this the value of 1370 is subtracted from the actual ngot height, so that the actual ingot height is now in the range of 0-700 for ngot heights of 65-100%

Citect: Averaged Ingot Height

Ingot height as sent to Citect

```
 +GRT---------------+                                      +SUB---------------+
-+GREATER THAN      +--------------------------------------+SUBTRACT          +
 |Source A     N7:30|                                      |Source A     N7:30|
 |                1793|                                    |                1793|
 |Source B     N7:34|                                      |Source B      1370|
 |                1400|                                    |                   |
 +------------------+                                      |Destination  N20:1|
                                                           |                 423|
                                                           +------------------+
```

ung 13:2

Citect:UCL Upper Control Limit for Ingots

```
                                                          +MOV---------------+
----------------------------------------------------------+MOVE              +
                                                          |Source       N7:36|
                                                          |                 575|
                                                          |Destination  N20:3|
                                                          |                 575|
                                                          +------------------+
```

ung 13:3

Citect:LCL Lower Control Limit for Ingots

MOV	
MOVE	
Source	N7:37 485
Destination	N20:4 485

ung 13:4

f the ingot height is less than 1400 on the 0-2070 scale it can be considered s undersize, and a constant value will be displayed on Citect which is out of ne control range.

Citect: Averaged Ingot Height

LES	
LESS THAN	
Source A	N7:30 1793
Source B	N7:35 1400

Ingot height as sent to Citect

MOV	
MOVE	
Source	N7:40 0
Destination	N20:1 423

ung 13:5

ne maximum value for ingot height as read by the Ingot Sensor is 2070 (on a cale of 0-4095) the value of 175 is subtracted from it to obtain the setpoint esired.A value of 1895 corresponds to an ingot height of 76mm.

Ingot Height Control Setpoint

SUB	
SUBTRACT	
Source A	N7:415 2070
Source B	N7:400 170
Destination	N7:31 1900

ung 13:6
rom the ingot height setpoint obtained above the trends on Citect are to
ompressed, to improve this the value of 1370 is subtracted from the previous
etpoint. So that the scale becomes 0-700 for ingot heights of 65% to 100%
nstead of 0-2070 for ingot heights of 0-100%.

Ingot Height Setpoint as sent to Citect

```
                                                          +SUB----------------+
----------------------------------------------------------+SUBTRACT           +
                                                          |Source A     N7:31 |
                                                          |                1900 |
                                                          |Source B      1370 |
                                                          |                   |
                                                          |Destination  N20:2 |
                                                          |                 530 |
                                                          +-------------------+
```

ung 13:7
he launder level control system setpoint can be in the range of 0-1000
he value in N7:52 is the setpoint required and is determined in the PID loop.
he Destination N20:10 is the address where Citect looks for the setpoint.

Citect: Launder Level Setpoint

```
                                                          +MOV----------------+
----------------------------------------------------------+MOVE               +
                                                          |Source       N7:52 |
                                                          |                 500 |
                                                          |Destination N20:10 |
                                                          |                 500 |
                                                          +-------------------+
```

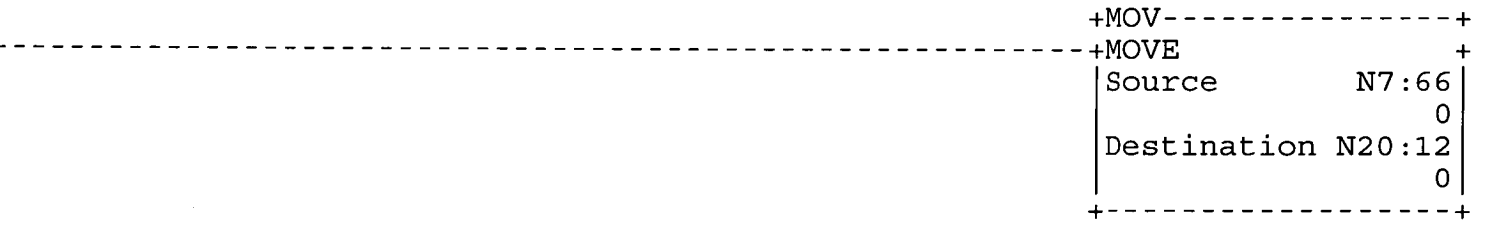
ung 13:8
he launder level process variable (actual launder metal level) can be anywher
the range of 0-1000. The value in the destination is the value of the
under metal level sent to Citect display.

Citect: Launder Level PV Value

```
                                                          +MOV----------------+
----------------------------------------------------------+MOVE               +
                                                          |Source      N7:300 |
                                                          |                1000 |
                                                          |Destination N20:11 |
                                                          |                1000 |
                                                          +-------------------+
```

ung 13:9
ne output value sent to the proportional valve to tilt the furnace is
ontained in address N7:66 and is in the range of 0-100%, the value is also
ent to the Citect Display.

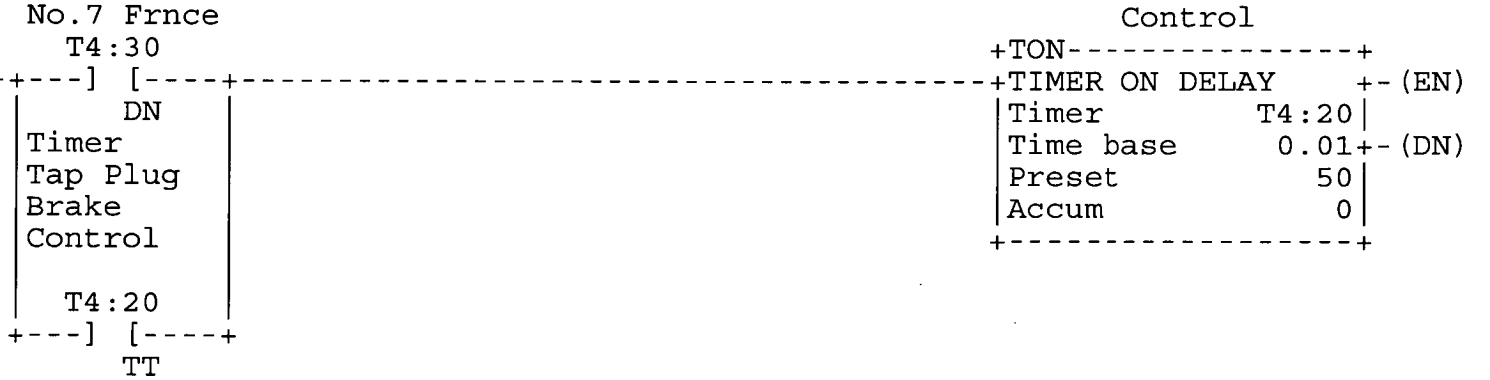
Citect:
Furnace
Hydraulics
Proptional
Valve



ung 13:10
his timer is used to "Reverse" the Tap Plug movement. This is to ensure promp
topping of the stroke when the insert action is used.

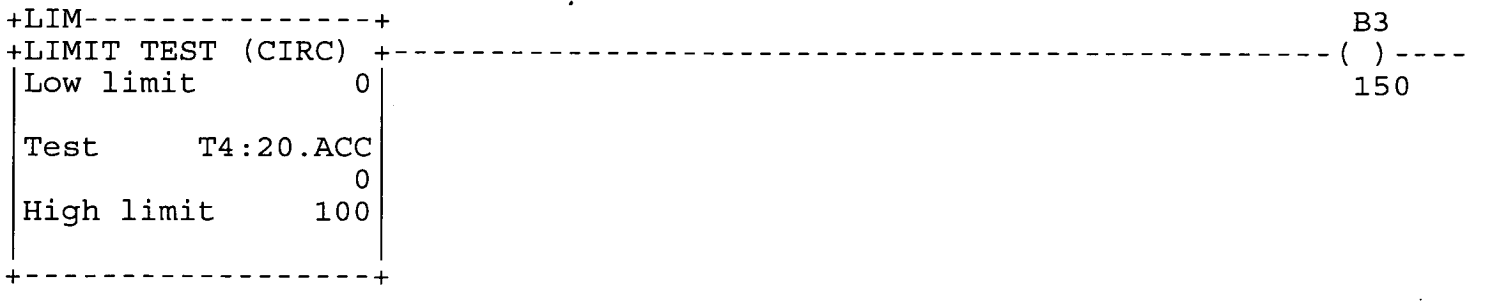
Timer:
Decrease
Launder
Level from
No.7 Frnce

Timer
Tap Plug
Brake
Control



ung 13:11

Oneshot:
Sensor at
Ingot Mold
Centre



ung 13:12

```
 +LIM---------------+                                                  B3
-+LIMIT TEST (CIRC) +-------------------------------------------------( )-
 |Low limit      110|                                                  151
 |                  |
 |Test     T4:20.ACC|
 |                0 |
 |High limit     220|
 |                  |
 +------------------+
```

ung 13:13

```
 +LIM---------------+                                                  B3
-+LIMIT TEST (CIRC) +-------------------------------------------------( )-
 |Low limit      230|                                                  152
 |                  |
 |Test     T4:20.ACC|
 |                0 |
 |High limit     330|
 |                  |
 +------------------+
```

ung 13:14

```
 +LIM---------------+                                                  B3
-+LIMIT TEST (CIRC) +-------------------------------------------------( )-
 |Low limit      340|                                                  153
 |                  |
 |Test     T4:20.ACC|
 |                0 |
 |High limit     440|
 |                  |
 +------------------+
```

ung 13:15

```
 +LIM---------------+                                                  B3
-+LIMIT TEST (CIRC) +-------------------------------------------------( )-
 |Low limit      450|                                                  154
 |                  |
 |Test     T4:20.ACC|
 |                0 |
 |High limit     550|
 |                  |
 +------------------+
```

ung 13:16

```
 +LIM---------------+                                                  B3
-+LIMIT TEST (CIRC) +-------------------------------------------------( )-
 |Low limit      560|                                                  155
 |                  |
 |Test     T4:20.ACC|
 |                0 |
 |High limit     660|
 |                  |
 +------------------+
```

ung 13:17

```
                                                                  STATUS:
 Oneshot:                                                         Slow
 Sensor at                                                        Movement
 Ingot Mold                                                       Control
 Centre                                                           (Lo Side)
     B3                                                              B3
----]/[-------------------------------------------------------------( )----
     150                                                             160
```

ung 13:18

```
   B3                                                                B3
--]/[---------------------------------------------------------------( )-
   151                                                               161
```

ung 13:19

```
   B3                                                                B3
--]/[---------------------------------------------------------------( )-
   152                                                               162
```

ung 13:20

```
   B3                                                                B3
--]/[---------------------------------------------------------------( )-
   153                                                               163
```

ung 13:21

```
   B3                                                                B3
--]/[---------------------------------------------------------------( )-
   154                                                               164
```

ung 13:22

```
   B3                                                                B3
--]/[---------------------------------------------------------------( )-
   155                                                               165
```

ung 13:23

[END OF FILE]

O MORE FILES

Allen-Bradley Company
6200 Series Software
PLC-5 Programming Terminal Software
Release 4.4
Cross Reference Report

Processor File: 06_6FNC
Wed Nov 10, 1993 - 3:38:49 pm

REPORT OPTIONS

Page Width:	80
Page Length:	66
Graphics Capabilities:	NO
Sort Order:	Address
Address Comments:	YES
Mnemonics:	YES
Starting Type:	A
Ending Type:	T

ddress	Symbol / Instruction	Comment / Program File Number:Rung Number
		Jump to Subroutine No.3 (System Control)
-JSR-	2:0	
		Jump to Subroutine No.4 (Hydraulic Control)
-JSR-	2:1	
		Jump to Subroutine No.5 (Datataker Control)
-JSR-	2:2	
		Jump to Subroutine No.6 (Alarming to see)
-JSR-	2:3	
		Jump to Subroutine No.7 (Block Transfers)
-JSR-	2:4	
		Jump to Subroutine No.8 (PID Control)
-JSR-	2:5	
0		Jump to Subroutine No.10
-JSR-	2:6	
1		Jump to Subroutine No.11 (No.7 Furnace)
-JSR-	2:7	
2		Jump to Subroutine No.12 (Ingot Height)
-JSR-	2:8	
3		Jump to Subroutine No.13 (Citect Control)
-JSR-	2:9	
3/1		Status: Ingot M/C Fault Not Accepted
-] [-	6:1 6:2 6:3	
-( )-	6:1	
3/2		Status: Main C/B Fault Not Accepted
-] [-	6:4 6:5 6:6	
-( )-	6:4	
3/3		Status: Element O/Temp Fault Not Accepted
-] [-	6:7 6:8 6:9	
-( )-	6:7	
3/4		Status: Furnace Over-Temp Fault Not Accepted
-] [-	6:10 6:11 6:12	
-( )-	6:10	
3/5		Status: Element 1 Fault Not Accepted
-] [-	6:13 6:14 6:15	
-( )-	6:13	
3/6		Status: Element 2 Fault Not Accepted
-] [-	6:16 6:17 6:18	
-( )-	6:16	
3/7		Status: Element 3 Fault Not Accepted
-] [-	6:19 6:20 6:21	
-( )-	6:19	
3/8		Status: Element 4 Fault Not Accepted
-] [-	6:22 6:23 6:24	
-( )-	6:22	
3/9		Status: Element 5 Fault Not Accepted
-] [-	6:25 6:26 6:27	
-( )-	6:25	
3/10		Status: Element 6 Fault Not Accepted
-] [-	6:28 6:29 6:30	
-( )-	6:28	

ddress	Symbol / Instruction	Comment / Program File Number:Rung Number
3/11		Status: Element 7 Fault Not Accepted
	-] [- 6:31 6:32 6:33	
	-( )- 6:31	
3/12		Status: Element 8 Fault Not Accepted
	-] [- 6:34 6:35 6:36	
	-( )- 6:34	
3/16		Status: Element 9 Fault Not Accepted
	-] [- 6:37 6:38 6:39	
	-( )- 6:37	
3/17		Status: Element 10 Fault Not Accepted
	-] [- 6:40 6:41 6:42	
	-( )- 6:40	
3/18		Status: Element 11 Fault Not Accepted
	-] [- 6:43 6:44 6:45	
	-( )- 6:43	
3/19		Status: Element 12 Fault Not Accepted
	-] [- 6:46 6:47 6:48	
	-( )- 6:46	
3/20		Status: Element 13 Fault Not Accepted
	-] [- 6:49 6:50 6:51	
	-( )- 6:49	
3/21		Status: Element 14 Fault Not Accepted
	-] [- 6:52 6:53 6:54	
	-( )- 6:52	
3/22		Status: Element 15 Fault Not Accepted
	-] [- 6:55 6:56 6:57	
	-( )- 6:55	
3/23		Status: Hydraulics Trip Fault Not Accepted
	-] [- 6:58 6:59 6:60	
	-( )- 6:58	
3/24		Status: Oil Level Fault Not Accepted
	-] [- 6:61 6:62 6:63	
	-( )- 6:61	
3/25		Status: Oil Temp. Fault Not Accepted
	-] [- 6:64 6:65 6:66	
	-( )- 6:64	
3/26		Status: Fast Filt. Fault Not Accepted
	-] [- 6:67 6:68 6:69	
	-( )- 6:67	
3/27		Status: Slow Filt. Fault Not Accepted
	-] [- 6:70 6:71 6:72	
	-( )- 6:70	
3/32		Status: Water Flow Fault Not Indicated
	-] [- 6:73 6:74 6:75	
	-( )- 6:73	
3/33		Status: Water Temp Fault Not Accepted
	-] [- 6:76 6:77 6:78	
	-( )- 6:76	
3/34		Status: PLC Batt. Fault Not Accepted
	-] [- 6:79 6:80 6:81	
	-( )- 6:79	

ddress	Symbol / Instruction	Comment / Program File Number:Rung Number
3/35		Status: SCR Fuse Fault Not Accepted
-] [-	6:82 6:83 6:84	
-( )-	6:82	
3/36		Status: Oil Press. Fault Not Accepted
-] [-	6:85 6:86 6:87	
-( )-	6:85	
3/48		Status: Ingot M/C Fault Accepted
-] [-	6:2 6:3	
-]/[-	6:1	
-( )-	6:2	
3/49		Status: Main C/B Fault Accepted
-] [-	6:5 6:6	
-]/[-	6:4	
-( )-	6:5	
3/50		Status: Element O/Temp Fault Accepted
-] [-	6:8 6:9	
-]/[-	6:7	
-( )-	6:8	
3/51		Status: Furnace Over-Temp Fault Accepted
-] [-	6:11 6:12	
-]/[-	6:10	
-( )-	6:11	
3/52		Status: Element 1 Fault Accepted
-] [-	6:14 6:15	
-]/[-	6:13	
-( )-	6:14	
3/53		Status: Element 2 Fault Accepted
-] [-	6:17 6:18	
-]/[-	6:16	
-( )-	6:17	
3/54		Status: Element 3 Fault Accepted
-] [-	6:20 6:21	
-]/[-	6:19	
-( )-	6:20	
3/55		Status: Element 4 Fault Accepted
-] [-	6:23 6:24	
-]/[-	6:22	
-( )-	6:23	
3/56		Status: Element 5 Fault Accepted
-] [-	6:26 6:27	
-]/[-	6:25	
-( )-	6:26	
3/57		Status: Element 6 Fault Accepted
-] [-	6:29 6:30	
-]/[-	6:28	
-( )-	6:29	
3/58		Status: Element 7 Fault Accepted
-] [-	6:32 6:33	
-]/[-	6:31	
-( )-	6:32	

ddress	Symbol / Instruction	Comment / Program File Number:Rung Number
3/59		Status: Element 8 Fault Accepted
-] [-	6:35 6:36	
-]/[-	6:34	
-( )-	6:35	
3/64		Status: Element 9 Fault Accepted
-] [-	6:38 6:39	
-]/[-	6:37	
-( )-	6:38	
3/65		Status: Element 10 Fault Accepted
-] [-	6:41 6:42	
-]/[-	6:40	
-( )-	6:41	
3/66		Status: Element 11 Fault Accepted
-] [-	6:44 6:45	
-]/[-	6:43	
-( )-	6:44	
3/67		Status: Element 12 Fault Accepted
-] [-	6:47 6:48	
-]/[-	6:46	
-( )-	6:47	
3/68		Status: Element 13 Fault Accepted
-] [-	6:50 6:51	
-]/[-	6:49	
-( )-	6:50	
3/69		Status: Element 14 Fault Accepted
-] [-	6:53 6:54	
-]/[-	6:52	
-( )-	6:53	
3/70		Status: Element 15 Fault Accepted
-] [-	6:56 6:57	
-]/[-	6:55	
-( )-	6:56	
3/71		Status: Hydraulics Trip Fault Accepted
-] [-	6:59 6:60	
-]/[-	6:58	
-( )-	6:59	
3/72		Status: Oil Level Fault Accepted
-] [-	6:62 6:63	
-]/[-	6:61	
-( )-	6:62	
3/73		Status: Oil Temp Fault Accepted
-] [-	6:65 6:66	
-]/[-	6:64	
-( )-	6:65	
3/74		Status: Fast Filt. Fault Accepted
-] [-	6:68 6:69	
-]/[-	6:67	
-( )-	6:68	
3/75		Status: Slow Filt. Fault Accepted
-] [-	6:71 6:72	
-]/[-	6:70	
-( )-	6:71	

ddress	Symbol / Instruction	Comment / Program File Number:Rung Number
3/80		Status: Water Flow Fault Accepted
-] [-	6:74 6:75	
-]/[-	6:73	
-( )-	6:74	
3/81		Status: Water Temp Fault Accepted
-] [-	6:77 6:78	
-]/[-	6:76	
-( )-	6:77	
3/82		Status: PLC Fault Accepted
-] [-	6:80 6:81	
-]/[-	6:79	
-( )-	6:80	
3/83		Status: SCR Fuse Fault Accepted
-] [-	6:83 6:84	
-]/[-	6:82	
-( )-	6:83	
3/84		Status: Oil Press. Fault Accepted
-] [-	6:86 6:87	
-]/[-	6:85	
-( )-	6:86	
3/112		Status: Fast Raise Request
-] [-	3:22 3:24 3:27 3:29 4:14	
-]/[-	3:20	
-( )-	3:16	
3/113		Status: Slow Raise Request
-] [-	3:23 3:24 3:28 3:29 4:2 4:4 4:15	
-( )-	3:17	
3/114		Status: Hold Request
-] [-	3:26 3:32 4:15	
-]/[-	4:14	
-( )-	3:18	
3/115		Status: Lower Request
-] [-	3:25 3:31 4:7 4:10 4:12	
-]/[-	4:10 4:14 4:15	
-( )-	3:19	
3/116		Status: No Hydraulic Request
-] [-	3:21	
-( )-	3:20	
3/117		Status: No Fast Hydraulic Request
-] [-	4:0	
-]/[-	4:2 4:7	
-( )-	3:21	
3/118		Status: Lower Operation Auxiliary
-] [-	4:10	
-]/[-	4:10	
-( )-	4:12	
3/119		Status: O.K. To Operate Doors
-] [-	4:21 4:26 4:29	
-( )-	4:20	

ddress	Symbol / Instruction	Comment / Program File Number:Rung Number
3/128		Status: No.1 Ingot Station Master
	-] [-	3:16 3:17 3:18 3:18 3:19 3:22 3:23 3:24 3:24 3:25 3:26
	-]/[-	3:13
	-( )-	3:12
3/129		Status: No.2 Ingot Station Master
	-] [-	3:14 3:16 3:17 3:18 3:18 3:19 3:27 3:28 3:29 3:29 3:31 3:32
	-]/[-	3:12
	-( )-	3:13
3/130		Status: Air Bleed Valve Aux.
	-] [-	4:14 4:38 4:39 4:40
	-( )-	4:38
3/131		Status: Hot Metal Door Man. Close
	-] [-	4:24 4:27
	-]/[-	4:25
	-( )-	4:24
3/132		Status: Element O/Current Aux 1.
	-] [-	3:7
	-( )-	3:6
3/133		Status: Element O/Current Aux 2.
	-]/[-	3:8
	-( )-	3:7
3/134		Status: Flash Timer Bit
	-] [-	3:33 6:3 6:6 6:9 6:12 6:15 6:18 6:21 6:24 6:27 6:30 6:33 6:36 6:39 6:42 6:45 6:48 6:51 6:54 6:57 6:60 6:63 6:66 6:69 6:72 6:75 6:78 6:81 6:84 6:87 10:5
3/135		Status: System Run
	-] [-	3:0 3:1 3:3 3:4 3:5 3:9 3:10 3:12 3:13 4:1 6:88 8:7 8:8 10:3 10:5
	-]/[-	3:2
	-( )-	3:0
3/136		Status: Clear To Tilt
	-] [-	3:16 3:17
	-( )-	3:15
3/137		Status: Hot Metal Door Open Request
	-] [-	4:26
	-]/[-	3:21
	-( )-	4:25
3/138		Status: Hot Metal Door Close Request
	-] [-	4:28
	-]/[-	3:21
	-( )-	4:27
3/139		Status: Crucible Tilt Auto. Down
	-] [-	4:30 4:31
	-( )-	4:30
3/140		Status: Manual Control Selected No.1
	-] [-	8:4
	-(L)-	8:0
	-(U)-	8:1
3/141		Status: Manual Control Selected No.2
	-] [-	8:4
	-(L)-	8:2
	-(U)-	8:3

ddress	Symbol / Instruction	Comment / Program File Number:Rung Number
3/142		Status: Manual Control Selected Aux. Relay
-] [-	8:5	
-]/[-	8:6 8:8 8:10	
-( )-	8:4	
3/143		Spare bit on the side
-]/[-	8:9	
-( )-	8:8	
3/150		Oneshot: Sensor at Ingot Mold Centre
-]/[-	13:17	
-( )-	13:11	
3/151		
-]/[-	13:18	
-( )-	13:12	
3/152		
-]/[-	13:19	
-( )-	13:13	
3/153		
-]/[-	13:20	
-( )-	13:14	
3/154		
-]/[-	13:21	
-( )-	13:15	
3/155		
-]/[-	13:22	
-( )-	13:16	
3/160		STATUS: Slow Movement Control (Lo Side)
-( )-	13:17	
3/161		
-( )-	13:18	
3/162		
-( )-	13:19	
3/163		
-( )-	13:20	
3/164		
-( )-	13:21	
3/165		
-( )-	13:22	
3/176		STATUS: Slow Movement Control (Hi Side)
-] [-	11:13	
-]/[-	11:14	
-( )-	11:11	
3/177		STATUS: Slow Movement Control (Lo Side)
-] [-	11:15	
-]/[-	11:16	
-( )-	11:12	
3/178		STATUS: Oneshot At Leading Edge of Mold
-ONS-	12:0	
3/179		STATUS: Oneshot Sensor at Centre of Mold
-] [-	12:2	
-ONS-	12:1	

```
ddress      Symbol /     Comment /
            Instruction  Program File Number:Rung Number

3/180                    STATUS:  Lower Weir Short   Pulse  Control
    -] [-   12:17
    -]/[-   12:18
    -( )-   12:11
3/181                    STATUS:  Raise Weir Short   Pulse  Control
    -] [-   12:15
    -]/[-   12:16
    -( )-   12:13
3/182                    STATUS:  Auto Ingot Height   Control  LOWER WEIR
    -] [-   12:17 12:18
    -( )-   12:12
3/183                    STATUS:  Auto Ingot Height   RAISE WEIR CONTROL
    -] [-   10:8 12:15 12:16
    -( )-   12:14
3/184                    STATUS:  Automatic  Level  Control  Engage
    -] [-   11:0 11:2 11:18 11:19
    -(L)-   11:4
    -(U)-   11:5
3/185                    STATUS:  Oneshot  To Engage  Auto Level Control
    -ONS-   11:4
3:0
    -MVM-   6:89 6:90
3:1
    -MVM-   6:89 6:90
3:2
    -MVM-   6:89 6:90
5:1                      Counter:  Bleed Off  Minute  Counter
    -CTU-   4:34
    -RES-   4:35
5:1.DN                   Counter:  Bleed Off  Minute  Counter
    -] [-   4:36
5:2                      Counter:  Bleed Off  Hour  Counter
    -CTU-   4:36
    -RES-   4:37
5:2.CU                   Counter:  Bleed Off  Hour  Counter
    -] [-   4:35
5:2.DN                   Counter:  Bleed Off  Hour   Counter
    -] [-   4:38
5:3                      Counter:  Change  To/From  Lower
    -CTU-   4:10
    -RES-   4:11
5:3.DN                   Counter:  Change  To/From  Lower
    -] [-   4:13
:002/00                  Input:  Launder  Maximum  Metal  Level Prox
    -] [-   10:0 11:5
    -]/[-   8:8
:002/01                  Input:  Launder  Minimum  Metal   Level Prox
    -] [-   10:1 11:5
    -]/[-   8:8
```

```
ddress      Symbol /     Comment /
            Instruction  Program File Number:Rung Number

:002/02                  Input:  Weir Open  Maximum  Prox
    -]/[-   10:4 10:8
:002/03                  Input:  Weir Fully Closed  Prox
    -]/[-   10:4 10:6 10:7
:002/04                  Input:  Weir Raise Pushbutton
    -] [-   10:4 10:6 10:7 10:8
:002/05                  Input:  Weir Lower Pushbutton
    -] [-   10:4 10:6 10:7
    -]/[-   10:8
:002/06                  Input:  Weir Fast  Speed  Selector   Switch
    -] [-   10:6
:002/07                  Input:  Weir Slow  Speed   Selector  Switch
    -] [-   10:7
:002/11                  Input:  Variable   Speed   Drive   Fault
    -]/[-   10:3
:002/12                  Input:    Weir  Automatic  Control  Select. SW
    -] [-   10:4 10:4 10:7 10:7 10:8 12:20 12:22
:002/14                  Input:   Tap Plug   IN P/B    at No.1   Machine
    -] [-   11:0
:002/15                  Input:  Tap Plug  OUT P/B  at No.1  Machine
    -] [-   11:2
:002/16                  Input:    Tap   Plug IN    P/B at 7   Furnace
    -] [-   11:0
:002/17                  Input:   Tap Plug   OUT P/B    at No.7   Furnace
    -] [-   11:2
:003/01                  Input:  Tap Plug  IN P/B   at No.2  Machine
    -] [-   11:0
:003/02                  Input:  Tap Plug  OUT P/B  at No.2  Machine
    -] [-   11:2
:003/03                  Input:  Cast No.7  Through  No.2 Ingot Machine
    -] [-   11:0 11:2
    -]/[-   11:0 11:2 11:4
:003/05                  Input:  Sensor at  Ingot Mold Centre
    -] [-   12:1
:003/06                  Input:  Sensor at  Ingot Mold Leading  Edge
    -] [-   12:0
:010/00                  Input:P/B   System    Stop
    -] [-   3:0
:010/01                  Input:P/B   System   Start
    -] [-   3:0
:010/02                  Input:  Ingot   Machine   O.K.
    -]/[-   6:1
:010/03                  Input:  Main C/B  Closed
    -] [-   3:10
    -]/[-   3:11 6:4
:010/07                  Input:  Elements  Not Over  Temp.
    -] [-   3:5
    -]/[-   6:7
:010/10                  Input:  Furnace  Not Over   Temp.
    -] [-   3:5
    -]/[-   6:10
```

ddress	Symbol / Instruction	Comment / Program File Number:Rung Number
:010/11		Input: Element No.1, not Tripped
-] [-	3:6	
-]/[-	6:13	
:010/12		Input: Element No.2, not Tripped
-] [-	3:6	
-]/[-	6:16	
:010/13		Input: Element No.3, not Tripped
-] [-	3:6	
-]/[-	6:19	
:010/14		Input: Element No.4, not Tripped
-] [-	3:6	
-]/[-	6:22	
:010/15		Input: Element No.5, not Tripped
-] [-	3:6	
-]/[-	6:25	
:010/16		Input: Element No.6, not Tripped
-] [-	3:6	
-]/[-	6:28	
:010/17		Input: Element No.7, not Tripped
-] [-	3:6	
-]/[-	6:31	
:011/00		Input: Element No.8,not Tripped
-] [-	3:7	
-]/[-	6:34	
:011/01		Input: Element No.9, not Tripped
-] [-	3:7	
-]/[-	6:37	
:011/02		Input: Element No.10, not Tripped
-] [-	3:7	
-]/[-	6:40	
:011/03		Input: Element No.11, not Tripped
-] [-	3:7	
-]/[-	6:43	
:011/04		Input: Element No.12, not Tripped
-] [-	3:7	
-]/[-	6:46	
:011/05		Input: Element No.13, not Tripped
-] [-	3:7	
-]/[-	6:49	
:011/06		Input: Element No.14, not Tripped
-] [-	3:7	
-]/[-	6:52	
:011/07		Input: Element No.15, not Tripped
-] [-	3:7	
-]/[-	6:55	
:011/10		Input: Hydraulic Motor Over/Load
-] [-	4:1	
-]/[-	6:58	
:011/11		Input: Hydraulic Motor Isol From Sub.
-] [-	4:1	

ddress Symbol / Comment /
Instruction Program File Number:Rung Number

```
:011/12                    Input:  Hydraulic  Motor   Local  Isolator
    -] [-   4:1
:011/13                    Input:  Hydraulic  Oil Low   Level
    -]/[-   4:1 6:61
:011/14                    Input:  Hydraulic  Oil Low  Pressure
    -] [-   4:0
:011/15                    Input:  Hydraulic  Oil Over  Temp.
    -] [-   4:1
    -]/[-   6:64
:011/16                    Input:  Hyd. Oil  Fast Speed Filter  Switch
    -]/[-   6:67
:011/17                    Input:  Hyd. Oil  Slow Speed Filter  Switch
    -]/[-   6:70
:012/00                    Input:  No.1 Tilt  Cylinder  Down
    -] [-   4:20 4:33
    -]/[-   4:2 4:4 4:7 4:35 4:37
:012/01                    Input:  No.2 Tilt  Cylinder  Down
    -] [-   4:20 4:33
    -]/[-   4:2 4:4 4:7 4:35 4:37
:012/04                    Input:  Go Home  PushButton
    -] [-   4:30
:012/05                    Input:  Furnace  Raise Sw.  At No.1  Machine
    -] [-   3:17 3:18 10:2
    -]/[-   3:18
:012/06                    Input:  Furnace  Lower Sw.  At No.1  Machine
    -] [-   3:19
    -]/[-   3:16 3:17 3:18 3:18
:012/07                    Input:  Inch   Furnace Up Pushbutton
    -] [-   4:29
    -]/[-   3:21 4:30
:012/10                    Input:  Fast Tilt  Pushbutton At No.1  Machine
    -] [-   3:16
    -]/[-   3:18
:012/11                    Input:  Inch  Furnace  Down  Pushbutton
    -] [-   4:31
    -]/[-   4:30
:012/12                    Input:  Main Door  Open  Selector  Switch
    -] [-   4:21
    -]/[-   3:20
:012/13                    Input:  Main Door  Close  Selector  Switch
    -] [-   4:22
    -]/[-   3:20
:012/14                    Input:  Main Door  Open Prox
    -]/[-   4:21
:012/15                    Input:  Main Door  Closed  Prox.
    -] [-   3:9 3:15
    -]/[-   3:33 4:22 5:0
:012/16                    Input:  MD Lintel  Water Low  Flow
    -]/[-   6:73
```

Address	Symbol / Instruction	Comment / Program File Number:Rung Number
:012/17		Input: MD Lintel Water O/Temp.
-]/[-	6:76	
:013/00		Input: Hot Metal Door Open Selector Switch
-] [-	4:23	
-]/[-	3:20 4:24	
:013/01		Input: Hot Metal Door Close Selector Switch
-] [-	4:24	
-]/[-	3:20	
:013/02		Input: Hot Metal Door Open Prox
-] [-	4:29	
-]/[-	4:25	
:013/03		Input: Hot Metal Door Closed Prox
-] [-	3:15	
-]/[-	3:30 3:36 4:27 5:1	
:013/04		Input: Pour Spout Door Open Selector Switch
-] [-	4:18	
-]/[-	3:20	
:013/05		Input: Pour Spout Door Close Selector Switch
-] [-	4:19	
-]/[-	3:20	
:013/06		Input: Pour Spout Door Open Prox
-]/[-	4:18	
:013/07		Input: Pour Spout Door Close Sel.Switch
-]/[-	4:19	
:013/10		Input: Small Door Open Switch
-] [-	4:16	
-]/[-	3:20	
:013/11		Input: Small Door Close Switch
-] [-	4:17	
-]/[-	3:20	
:013/12		Input: Small Door Open Prox
-]/[-	4:16	
:013/13		Input: Small Door Closed Prox
-]/[-	4:17	
:013/14		Input: Alarm Accept Pushbutton
-] [-	6:2 6:5 6:8 6:11 6:14 6:17 6:20 6:23 6:26 6:29 6:32 6:35 6:38 6:41 6:44 6:47 6:50 6:53 6:56 6:59 6:62 6:65 6:68 6:71 6:74 6:77 6:80 6:83 6:86 6:90	
:013/15		Input: Alarm Reset Pushbutton
-]/[-	6:2 6:5 6:8 6:11 6:14 6:17 6:20 6:23 6:26 6:29 6:32 6:35 6:38 6:41 6:44 6:47 6:50 6:53 6:56 6:59 6:62 6:65 6:68 6:71 6:74 6:77 6:80 6:83 6:86	
:013/16		Input: P/B Lamp Test
-] [-	3:1 3:2 3:8 3:11 3:22 3:23 3:24 3:25 3:26 3:27 3:28 3:29 3:30 3:31 3:32 3:33 3:35 3:36 6:3 6:6 6:9 6:12 6:15 6:18 6:21 6:24 6:27 6:30 6:33 6:36 6:39 6:42 6:45 6:48 6:51 6:54 6:57 6:60 6:63 6:66 6:69 6:72 6:75 6:78 6:81 6:84 6:87	
:027/00		Input: Crucible Tilter At 30 Degrees
-] [-	3:21	
-]/[-	4:32	

ddress Symbol / Comment /
Instruction Program File Number:Rung Number

```
:027/01                 Input:   Crucible   Table   Home   Prox
    -] [-   3:15 3:21 4:27
    -]/[-   3:35 4:23 4:30 4:32
:027/02                 Input:  Heat   Sensor At  Hot Metal  Door
    -] [-   4:23
:027/03                 Input:  Crucible  Table Home Prox
    -] [-   4:24
    -]/[-   4:23
:027/04                 Input:    SCR  Blown Fuse   Relay
    -] [-   3:10
:027/05                 Input:  No.1 Ingot Station   Selected
    -] [-   3:12 8:0 8:1 8:3
:027/06                 Input:  No.2 Ingot Station  Selected
    -] [-   3:13 8:1 8:2 8:3
:027/07     XIO         Input:No.6 Automatic  Tilt  Select At  No.1 M/C
    -] [-   8:1 8:6 8:8 10:2
    -]/[-   3:18 8:0
:027/10                 Input:No.7 Automatic  Level  Select At  No.1 M/C
    -] [-   11:4
    -]/[-   3:18 8:0 11:5
:027/12                 Input:  Furnace 6  Raise Sw.  At No.2  Machine
    -] [-   3:17 3:18
    -]/[-   3:18
:027/13                 Input:  Manual  Tilt No.6  Select At  No.2 M/C
    -] [-   3:18 8:2
:027/14                 Input:  Automatic  Tilt No.6  Select At  No.2 M/C
    -] [-   3:17 8:3
:027/15                 Input:  Furnace 6  Lower Sw.  At No.2  Machine
    -] [-   3:19
    -]/[-   3:16 3:17 3:18 3:18
:027/16                 Input:  Fast Tilt  Pushbutton At No.2  Machine
    -] [-   3:16
    -]/[-   3:18
7:0                     Launder  Level  PID   Control  block
    -MOV-   8:6
    -PID-   8:7
7:5                     Launder  Level  PID   Control  block
    -PID-   8:7
7:10
    -MOV-   8:9 8:10
    -PID-   8:7
7:20                    Alarm  Buffer  Word No.1
    -MVM-   6:89
    -NEQ-   6:91
7:21                    Alarm  Buffer  Word No.2
    -MVM-   6:89
    -NEQ-   6:91
7:22                    Alarm  Buffer   Word No.3
    -MVM-   6:89
    -NEQ-   6:91
```

ddress	Symbol / Instruction	Comment / Program File Number:Rung Number
7:23		Alarm Buffer Word No.4
-MVM-	6:90	
-NEQ-	6:91	
7:24		Alarm Buffer Word No.5
-MVM-	6:90	
-NEQ-	6:91	
7:25		Alarm Buffer Word No.6
-MVM-	6:90	
-NEQ-	6:91	
7:30		Citect: Averaged Ingot Height
-GRT-	13:1	
-LES-	13:4	
-SUB-	13:0 13:1	
7:31		Ingot Height Control Setpoint
-SUB-	13:5 13:6	
7:34		
-GRT-	13:1	
7:35		
-LES-	13:4	
7:36		Ingot Height Upper Control Limit
-MOV-	13:2	
7:37		Ingot Height Lower Control Limit
-MOV-	13:3	
7:39		
-MOV-	8:9	
7:40		
-MOV-	13:4	
':50		Launder Level PID Control block
-PID-	8:7	
':50/15		PID Control Enabled Bit
-(U)-	8:7	
':52		
-ADD-	11:8	
-MOV-	13:7	
-SUB-	11:9	
':66		
-MOV-	13:9	
:100		
-BTR-	7:0	
:104		
-DIV-	11:6	
-MOV-	8:6	
:105		
-MOV-	8:5	
:106		
-MOV-	3:4	
:107		
-MOV-	12:0 12:1	
:150		
-BTW-	7:1	

ddress	Symbol / Instruction	Comment / Program File Number:Rung Number
7:200		
	-BTR- 7:2	
7:250		Analogue output Channel 1
	-BTW- 7:3	
	-MOV- 8:5 8:10	
7:251		MOVE DATA TO DISPLAY
	-MOV- 3:4	
7:300		Launder Level Scaled Input Value
	-DIV- 11:6	
	-GEQ- 11:18	
	-GRT- 11:5 11:11	
	-LEQ- 11:19	
	-LES- 11:5 11:12	
	-LIM- 11:11 11:12	
	-MOV- 13:8	
7:301		Launder Level Lower Control Limit
	-LIM- 11:12	
	-SUB- 11:10	
7:302		
	-SUB- 11:10	
7:303		Launder Level Deadband Lower Limit
	-LEQ- 11:19	
	-LES- 11:12	
	-LIM- 11:12	
	-SUB- 11:9 11:10	
7:304		
	-SUB- 11:9	
7:305		
	-ADD- 11:8	
7:306		Launder Level Deadband Upper Limit
	-ADD- 11:7 11:8	
	-GEQ- 11:18	
	-GRT- 11:11	
	-LIM- 11:11	
7:307		
	-ADD- 11:7	
7:308		Launder Level Upper Control Limit
	-ADD- 11:7	
	-LIM- 11:11	
7:310		
	-MOV- 11:13	
7:311		
	-MOV- 11:14	
7:312		
	-MOV- 11:15	
7:313		
	-MOV- 11:16	
7:320		Auto Level Control High Limit Cut Out Buffer
	-GRT- 11:5	

ddress	Symbol / Instruction	Comment / Program File Number:Rung Number
7:321		Auto Level Control Low Limit Cut Out Buffer
	-LES- 11:5	
7:340		Ingot Mould Edge Height Buffer
	-MOV- 12:0	
	-SUB- 12:1	
7:341		Ingot Height in Mould Buffer
	-MOV- 12:1	
	-SUB- 12:1	
7:342		Difference between Ingot & Mould Buffer
	-FFL- 12:2	
	-SUB- 12:1	
7:350		
	-ADD- 12:4 12:5	
	-FFL- 12:2	
	-MOV- 12:3	
7:351		
	-ADD- 12:4 12:5	
7:352		
	-ADD- 12:5	
7:360		Ingot Height Result Buffer 1
	-ADD- 12:4 12:5 12:5	
	-DIV- 12:4	
7:361		Ingot Height Result Buffer 2
	-ADD- 12:5	
	-DIV- 12:5	
7:365		Control: Averaged Ingot Height
	-DIV- 12:4 12:5	
	-GEQ- 12:20	
	-GRT- 12:13 12:14	
	-LEQ- 12:22	
	-LES- 12:11 12:12	
	-LIM- 12:11 12:13	
	-MOV- 12:3	
	-SUB- 13:0	
7:400		Ingot Height Setpoint Control Buffer
	-ADD- 12:7	
	-SUB- 12:9 13:5	
7:401		Ingot Height S/point DB Hi Adjust Buffer
	-ADD- 12:7	
7:402		Ingot Height S/point Hi Side Deadband
	-ADD- 12:7 12:8	
	-LEQ- 12:22	
	-LES- 12:11 12:12	
	-LIM- 12:11	
7:403		Ingot Height Slow/Fast Hi Adjust Buffer
	-ADD- 12:8	
7:404		Ingot Height Long/Short Pulse Hi Limit
	-ADD- 12:8	
	-LIM- 12:11	

ddress	Symbol / Instruction	Comment / Program File Number:Rung Number
7:405		Ingot Height S/point DB Lo Adjust Buffer
-SUB-	12:9	
7:406		Ingot Height Lo S/point Deadband Control
-GEQ-	12:20	
-GRT-	12:13 12:14	
-LIM-	12:13	
-SUB-	12:9 12:10	
7:407		Ingot Height Slow/Fast Lo Adjust Buffer
-SUB-	12:10	
7:408		Ingot Height Long/Short Pulse Lo Limit
-LIM-	12:13	
-SUB-	12:10	
7:410		Ingot Hght Slow Control Preset (Hi side)
-MOV-	12:15	
7:411		Ingot Hght Fast Control Preset (Hi Side)
-MOV-	12:16	
7:412		Ingot Hght Slow Control Preset (Lo Side)
-MOV-	12:17	
7:413		Ingot Hght Fast Control Preset (Lo Side)
-MOV-	12:18	
7:415		
-SUB-	13:0 13:5	
9:0		Blk Trans. Read Instruct. for Analog In Module
-BTR-	7:0	
9:0/15		BTR ANA. INPUT RACK 0 MOD.0 ENABLED
-]/[-	7:0 7:1	
9:50		Blk Trans. Write To Analog Input Mod.
-BTW-	7:1	
9:50/15		BTW ANA. INPUT RACK 0 MOD.0 ENABLED
-]/[-	7:0 7:1	
9:100		Blk Trans. Read for Analog Output Module
-BTR-	7:2	
9:100/15		BTR ANA.OUTPUT RACK 0 MOD. 1 ENABLED
-]/[-	7:2 7:3	
9:150		Blk Trans. Write to Analog Output Module
-BTW-	7:3	
9:150/15		BTW ANA.OUTPUT RACK 0 MOD.1 ENABLED
-]/[-	7:2 7:3	
10:1		Ingot height as sent to Citect
-MOV-	13:4	
-SUB-	13:1	
10:2		Ingot Height Setpoint as sent to Citect
-SUB-	13:6	
10:3		Citect:UCL Upper Control Limit for Ingots
-MOV-	13:2	
10:4		Citect:LCL Lower Control Limit for Ingots
-MOV-	13:3	
10:10		Citect: Launder Level Setpoint
-MOV-	13:7	

ddress	Symbol / Instruction	Comment / Program File Number:Rung Number
20:11		Citect: Launder Level PV Value
-MOV-	13:8	
20:12		Citect: Furnace Hydraulics Proptional Valve
-MOV-	13:9	
:005/00		Launder Level in Automatic Control Indicator
-( )-	10:2	
:005/01		Output: Max. Level In Launder Indicator
-( )-	10:0	
:005/02		Output: Min. Level In Launder Indicator
-( )-	10:1	
:005/03		Output: Variable Speed Drive Fault
-( )-	10:5	
:005/05		Output: Tap Plug IN Actuator
-] [-	11:1	
-]/[-	11:2	
-( )-	11:0	
:005/06		Output: Tap Plug IN Indicator
-( )-	11:1	
:005/07		Output: Tap Plug OUT Indicator
-( )-	11:3	
:005/14		Output: Tap Plug OUT Actuator
-] [-	11:3	
-]/[-	11:0	
-( )-	11:2	
:020/00		Output: System Off Indication Lamp
-( )-	3:2	
:020/01		Output: System On Indication Lamp
-( )-	3:1	
:020/05		Output: Furnace Elements Contactor
-] [-	3:9	
-( )-	3:5	
:020/10		Output: Element O/Current Indication Lamp
-( )-	3:8	
:020/11		Output: Hydraulic Motor Contactor
-] [-	4:3	
-( )-	4:1	
:020/13		Output: Furnace Raise Solenoid
-] [-	8:8	
-( )-	4:15	
:020/14		Output: Furnace Raise Lamp At No.1 Ingot M/C
-]/[-	3:26	
-( )-	3:24	
:020/15		Output: Furnace Lower Lamp At No.1 Ingot M/C
-]/[-	3:26	
-( )-	3:25	
:020/16		Output: Fast Tilt Speed Dump Solenoid
-] [-	4:9	
-( )-	4:8	
:020/17		Output: Fast Tilt Lamp At No.1 Ingot M/C
-( )-	3:22	

Address	Symbol / Instruction	Comment / Program File Number:Rung Number
O:021/00		Output: Slow Tilt Speed Dump Solenoid
-] [-	4:6	
-( )-	4:5	
O:021/01		Output: Slow Tilt Lamp At No.2 Ingot M/C
-( )-	3:23	
O:021/02		Output: Furnace Hold Lamp At No.1 Ingot M/C
-( )-	3:26	
O:021/03		Output: Fast Tilt Solenoid
-] [-	4:15 4:38	
-( )-	4:14	
O:021/04		Output: Main Door Open Solenoid
-( )-	4:21	
O:021/05		Output: Main Door Close Solenoid
-( )-	4:22	
O:021/06		Output: Hot Metal Door Open Solenoid
-( )-	4:26	
O:021/07		Output: Hot Metal Door Close Solenoid
-( )-	4:28	
O:021/10		Output: Pour Spout Door Open Solenoid
-( )-	4:18	
O:021/11		Output: Pour Spout Door Close Solenoid
-( )-	4:19	
O:021/12		Output: Small Door Open Solenoid
-( )-	4:16	
O:021/13		Output: Small Door Close Solenoid
-( )-	4:17	
O:021/14		Output: Alarm Horn
-( )-	6:91	
O:021/15		Output: SCR Control Relay
-] [-	3:10	
-( )-	3:9	
O:021/16		Output: Crucible Tilt Up Solenoid
-( )-	4:29	
O:021/17		Output: Furnace Auto Air Bleed Valve
-( )-	4:40	
O:022/00		Output: Element 1 O/C Alarm Indication Lamp
-( )-	6:15	
O:022/01		Output: Element 2 O/C Alarm Indication Lamp
-( )-	6:18	
O:022/02		Output: Element 3 O/C Alarm Indication Lamp
-( )-	6:21	
O:022/03		Output: Element 4 O/C Alarm Indication Lamp
-( )-	6:24	
O:022/04		Output: Element 5 O/C Alarm Indication Lamp
-( )-	6:27	
O:022/05		Output: Element 6 O/C Alarm Indication Lamp
-( )-	6:30	
O:022/06		Output: Element 7 O/C Alarm Indication Lamp
-( )-	6:33	

Address	Symbol / Instruction	Comment / Program File Number:Rung Number
:022/07		Output: Element 8 O/C Alarm Indication Lamp
-( )-	6:36	
:022/10		Output: Element 9 O/C Alarm Indication Lamp
-( )-	6:39	
:022/11		Output: Element 10 O/C Alarm Indication Lamp
-( )-	6:42	
:022/12		Output: Element 11 O/C Alarm Indication Lamp
-( )-	6:45	
:022/13		Output: Element 12 O/C Alarm Indication Lamp
-( )-	6:48	
:022/14		Output: Element 13 O/C Alarm Indication Lamp
-( )-	6:51	
:022/15		Output: Element 14 O/C Alarm Indication Lamp
-( )-	6:54	
:022/16		Output: Element 15 O/C Alarm Indication Lamp
-( )-	6:57	
:022/17		Output: Hydraulics O/C Alarm Indication Lamp
-( )-	6:60	
:023/00		Output: Hyd.Oil Low Level Indication Lamp
-( )-	6:63	
:023/01		Output: Hyd. Oil Low Press. Indication Lamp
-( )-	6:87	
:023/02		Output: Hyd. Oil O/Temp. Indication Lamp
-( )-	6:66	
:023/03		Output: Fast Speed Filt. Low Flow Indication
-( )-	6:69	
:023/04		Output: Slow Speed Filt. Low Flow Indication
-( )-	6:72	
:023/06		Output: MD Lintel Low Flow Indication Lamp
-( )-	6:75	
:023/07		Output: MD Lintel O/Temp Indication Lamp
-( )-	6:78	
:023/10		Output: P.L.C. Failure Indication Lamp
-( )-	6:81	
:023/11		Output: Ingot M/C Fault Indication lamp
-( )-	6:3	
:023/12		Output: Element O/Temp Indication
-( )-	6:9	
:023/13		Output: Furnace Over-Temp Indication Lamp
-( )-	6:12	
:023/14		Output: Main Door Open Indication Lamp
-] [-	3:34	
-( )-	3:33	
:023/15		Output: Hot Metal Door Indication Lamp
-( )-	3:30 3:36	
:023/16		Output: Main C/B Tripped Indication Lamp
-( )-	6:6	
:023/17		Output: Cruc. Tilt Table Up Lamp
-( )-	3:35	

Address	Symbol / Instruction	Comment / Program File Number:Rung Number
O:024/00		Output: SCR Blown Fuse Mimic
-( )-	6:84	
O:025/00		Output: SCR Blown Fuse Indication Lamp
-( )-	3:11	
O:025/01		Output: Main Door Open Mimic Indication Lamp
-( )-	3:34	
O:025/02		Output: Metal door Open Datataker Relay
-( )-	5:0	
O:025/03		Output: Hot Metal Door Open Datataker Relay
-( )-	5:1	
O:025/04		Output: Select No.2 M/C Tilt Relay
-( )-	3:14	
O:025/05		Output: Furnace Lower Lamp At No.2 Ingot M/C
-( )-	3:31	
O:025/06		Output: Furnace Fast Tilt At No.2 Ingot M/C
-( )-	3:27	
O:025/07		Output: Furnace Slow Tilt At No.2 Ingot M/C
-( )-	3:28	
O:025/10		Output: Furnace Hold Lamp At No.2 Ingot M/C
-( )-	3:32	
O:025/11		Output: Furnace Raise Lamp At No.2 Ingot M/C
-( )-	3:29	
O:025/12		Output: Crucible Tilt Down Solenoid
-( )-	4:31	
O:025/13		Output: Bail Arm Lock Solenoid
-( )-	4:32	
O:026/00		Output: Weir Speed Slow
-]/[-	10:6	
-( )-	10:7	
O:026/01		Output: Weir Speed Fast
-]/[-	10:7	
-( )-	10:6	
O:026/02		Output: Weir Raise/ Lower
-( )-	10:8	
O:026/03		Output: Variable Speed Drive Stop
-( )-	10:4	
O:026/04		Output: Variable Speed Drive Start
-]/[-	10:5	
-( )-	10:3	
6:0		Control: Ingot Height Control FIFO
-FFL-	12:2	
6:0.LEN		Control: Ingot Height Averaging FIFO Len.
-EQU-	12:3 12:4 12:6	
6:0.POS		Control: Ingot Height Averaging FIFO
-EQU-	12:3 12:4 12:6	
-MOV-	12:6	
O:10/0		Status: P.L.C. Battery Low Or Failed
-] [-	6:79	
4:1		Timer: Slow Pump Available
-TON-	4:6	

Address	Symbol / Instruction	Comment / Program File Number:Rung Number
T4:1.DN		Timer: Slow Pump Available
-] [-	4:15	
T4:2		Timer; Hydraulic Oil Low Pressure Fault
-TOF-	4:0	
T4:2.DN		Timer: Hydraulic Oil Low Pressure Fault
-] [-	4:1	
-]/[-	6:85	
T4:3		Flash Timer
-TON-	6:0	
T4:3.DN		Flash Timer
-]/[-	6:0	
T4:4		Bleed Off Timer
-TON-	4:39	
T4:4.DN		Timer: Bleed Off
-]/[-	4:38	
T4:5		Timer: Hot Metal Door Open
-TOF-	4:23	
T4:5.DN		Timer: Hold Hot Metal Door Open
-] [-	4:24 4:25	
-]/[-	4:27	
T4:6		Timer: Slow Unload Off
-TOF-	4:4	
T4:6.DN		Timer: Slow Unload Off
-] [-	4:5	
T4:7		Timer: Fast Tilt Unload Valve Off
-TOF-	4:7	
T4:7.DN		Timer: Fast Unload Valve Off
-] [-	4:8	
T4:8		Timer: Fast Unload Available
-TON-	4:9	
T4:8.DN		Timer: Fast Unload Available
-] [-	4:13 4:14 4:14 4:16 4:17 4:18 4:19 4:20 4:22 4:28	
-]/[-	4:0	
T4:9		Timer: Hydraulic Pump Delay Off
-TOF-	4:2	
T4:9.DN		Timer: Hydraulic Pump Delay Off
-] [-	4:1	
T4:10		Timer: Hydraulic Pump Available
-TON-	4:3	
T4:10.DN		Timer: Hydraulic Pump Available
-] [-	4:5 4:8	
T4:11		Timer: Pulse Raise
-TON-	4:13	
T4:11.DN		Timer: Pulse Raise Timer
-] [-	4:11	
-]/[-	4:7 4:14	
T4:11.EN		Timer: Pulse Raise Furnace
-] [-	3:16 4:7 4:14	
T4:12.DN		Timer: Change To/From Lower
-]/[-	3:21	

Address	Symbol / Instruction	Comment / Program File Number:Rung Number
T4:13		Timer: Furnace Start Alarm Preset
	-TON- 6:88	
T4:14		Timer: Validate SCR Fault
	-TON- 3:10	
T4:14.DN		Timer: Validate SCR Fault
	-] [- 3:11 6:82	
T4:15		Timer: Furnace Down
	-TON- 4:33	
T4:15.DN		Timer: Furnace Down
	-] [- 4:34	
	-]/[- 4:33	
T4:19		DISPLAY UPDATE TIMER
	-TON- 3:3	
T4:19.DN		DISPLAY UPDATE TIMER DONE
	-] [- 3:4	
	-]/[- 3:3	
T4:20		Timer Tap Plug Brake Control
	-TON- 13:10	
T4:20.ACC		
	-LIM- 13:11 13:12	13:13 13:14 13:15 13:16
T4:20.TT		Timer Tap Plug Brake Control
	-] [- 11:2 13:10	
	-]/[- 11:18	
T4:29		Timer: Decrease Level Control Off
	-TON- 11:17	
T4:29.TT		Timer: Decrease Level Control Off
	-] [- 11:17	
	-]/[- 11:18	
T4:30		Timer: Decrease Launder Level from No.7 Frnce
	-TON- 11:18	
T4:30.DN		Timer: Decrease Launder Level from No.7 Frnce
	-] [- 11:17 13:10	
	-]/[- 11:18	
T4:30.PRE		Timer: Decrease Launder Level Control
	-MOV- 11:13 11:14	
T4:30.TT		Timer: Decrease Launder Level from No.7 Frnce
	-] [- 11:0	
	-]/[- 11:19	
T4:31		Timer: Increase Launder Level from No.7 Frnce
	-TON- 11:19	
T4:31.DN		Timer: Increase Launder Level from No.7 Frnce
	-] [- 11:20	
	-]/[- 11:19	
T4:31.PRE		TIMER: Increase Launder Level Control
	-MOV- 11:15 11:16	
T4:31.TT		Timer: Increase Launder Level from No.7 Frnce
	-] [- 11:2	
	-]/[- 11:18	
T4:32		Timer: Increase Level Control Off
	-TON- 11:20	

```
ddress        Symbol /      Comment /
              Instruction   Program File Number:Rung Number

4:32.TT                    Timer:  Increase  Level  Control  Off
    -] [-     11:20
    -]/[-     11:19
4:35                       TIMER:  Increase  Ingot Hght Level  Off Delay
    -TON-     12:19
4:35.TT                    TIMER:  Increase  Ingot Hght Level  Off Delay
    -] [-     12:19
    -]/[-     12:20 12:22
4:36                       TIMER:  Increase  Ingot Hght On Delay  Timer
    -TON-     12:20
4:36.DN                    TIMER:  Increase  Height  Off Delay  Control
    -] [-     12:19
4:36.PRE                   TIMER:  Increase  Height  Control  Preset
    -MOV-     12:15 12:16
4:36.TT                    TIMER:  Increase  Height  On Delay  Control
    -] [-     10:4 10:7
    -]/[-     12:22
4:37                       TIMER:  Decrease  Height  Off Delay  Control
    -TON-     12:21
4:37.TT                    TIMER:  Decrease  Height  Off Delay  Control
    -] [-     12:21
    -]/[-     12:20 12:22
4:38                       TIMER:  Decrease  Height  On Delay  Control
    -TON-     12:22
:38.DN                     TIMER:  Decrease  Height  On Delay  Control
    -] [-     12:21
:38.PRE                    TIMER:  Decrease  Height  Control  Preset
    -MOV-     12:17 12:18
4:38.TT                    TIMER:  Decrease  Height  On Delay  Control
    -] [-     10:4 10:7
    -]/[-     12:20
```

```
ëëëëëëëëëëëëëëëëëëëëëëëëë PLC-5 PROGRAMMING SOFTWARE ëëëëëëëëëëëëëëëëëëëëëëëëë
               èëë Print 06_6FNC ëëëëëëëëëëëëëëëëëëëëëëëëëë£
               ¤     Report                Size       Date      ¤
               úáááááááááááááááááááááááááááááááááááááááááááÑ
              C¤ * Ladder Listing        357055    11-10-93   ¤nc.
               ¤ * Program Cross Ref      50488    11-10-93   ¤
               ¤                                              ¤
               ¤                                              ¤
               ¤                                              ¤
   This softwar¤                                              ¤um Ltd
               ¤                                              ¤ects
               ¤                                              ¤
               ¤                                              ¤
               ¤                                              ¤
               ¤                                              ¤
               ¤                                              ¤
               ¤                                              ¤
ëëëëëëëëëëëëëëàëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëë¥ëëëëëëëëëëëëëëë
INT COMPLETE.
ess a function key
```